FINAL REVIEW DRAFT

DISTRICT HEATING PLANNING

IN MINNESOTA

A COMMUNITY GUIDEBOOK

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Prepared for the
MINNESOTA ENERGY AGENCY

by
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FOREWORD

Minnesota faces three significant energy problems. The state imports all its energy supplies from other states and countries. Second, those supplies are shrinking while their costs are rising. Finally, future demand for these fuels is expected to exceed supplies.

In order to balance this supply and demand picture, Minnesota must consider developing alternative energy technology. Solar, wind and biomass are the most commonly mentioned resources, but district heating is another that merits careful study.

District heating is the distribution of heat energy from a central source to commercial, industrial and residential customers for space heating, process needs, and domestic hot water.

District heating offers several advantages for Minnesota communities:

- It encourages economic growth by reducing energy costs, building local self-reliance and attracting new business
- It provides better long-run price stability
- It reduces thermal pollution and improves air quality

District heating, however, has one major disadvantage. It requires significant initial capital investment. Capital, not fuel or labor, is the most expensive cost element in the first few years and can run 60-85% of heat costs.

For this reason, district heating development requires a joint effort by private and public sectors. No one sector can assume total risk and secure the necessary financing.

The task is not impossible, however. Several Minnesota communities are meeting the challenge now with success.

District Heating Planning in Minnesota: A Community Guidebook is intended for use by local officials, planners, and citizens. It will help people determine whether a district heating system is feasible in their community. It will also guide people through each step of district heating development.

Acknowledgements

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Note: The 1981 Minnesota State Legislature established the Minnesota Department of Energy, Planning and Development, which combined the existing Minnesota Energy Agency, the Department of Economic Development, the State Planning Agency and the Minnesota Crime Control Board. The completion of the merger of the agencies requires additional action by the 1982 Legislature: the aforementioned agencies are referred to by their former names.

Consulting services were provided by Planning and Management Services, Inc., Bloomington, Minnesota, with assistance from Scantec, Inc. (district heating engineering services), Graven and Associates (economic research), and the Carroll Easton Company (district heating consulting services).

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SUMMARY OF CONTENTS

This Guidebook was written to help communities evaluate the feasibility of local district heating and to guide proponents through the development process.

SECTION 1.0 DISTRICT HEATING DEVELOPMENT: AN OVERVIEW highlights the major activities involved in such a project.

Section 2.0 INDEPENDENT ASSESSMENT is the first step communities take in the process. A questionnaire is provided to help proponents evaluate local conditions for district heating.

Section 3.0 FEASIBILITY SCREENING provides a step-by-step method for estimating the capital investment costs of a district heating system proposed for a specific community. These procedures enable a community to make an invaluable early assessment of the relative economic attractiveness of their proposed system and begin a detailed investigation and determination of the characteristics of each development component.

Section 4.0 PLANNING AND CONCEPTUAL DESIGN describes how to plan and design a district heating system. This section also describes how a community acquires the engineering, economic, and financial expertise required for this and subsequent phases.

Section 5.0 DESIGN / CONSTRUCTION / OPERATIONS briefly describes the planning and development process in the final planning phase -- Detailed Design and User Commitment -- and two following implementation phases -- System Construction and System Operations.

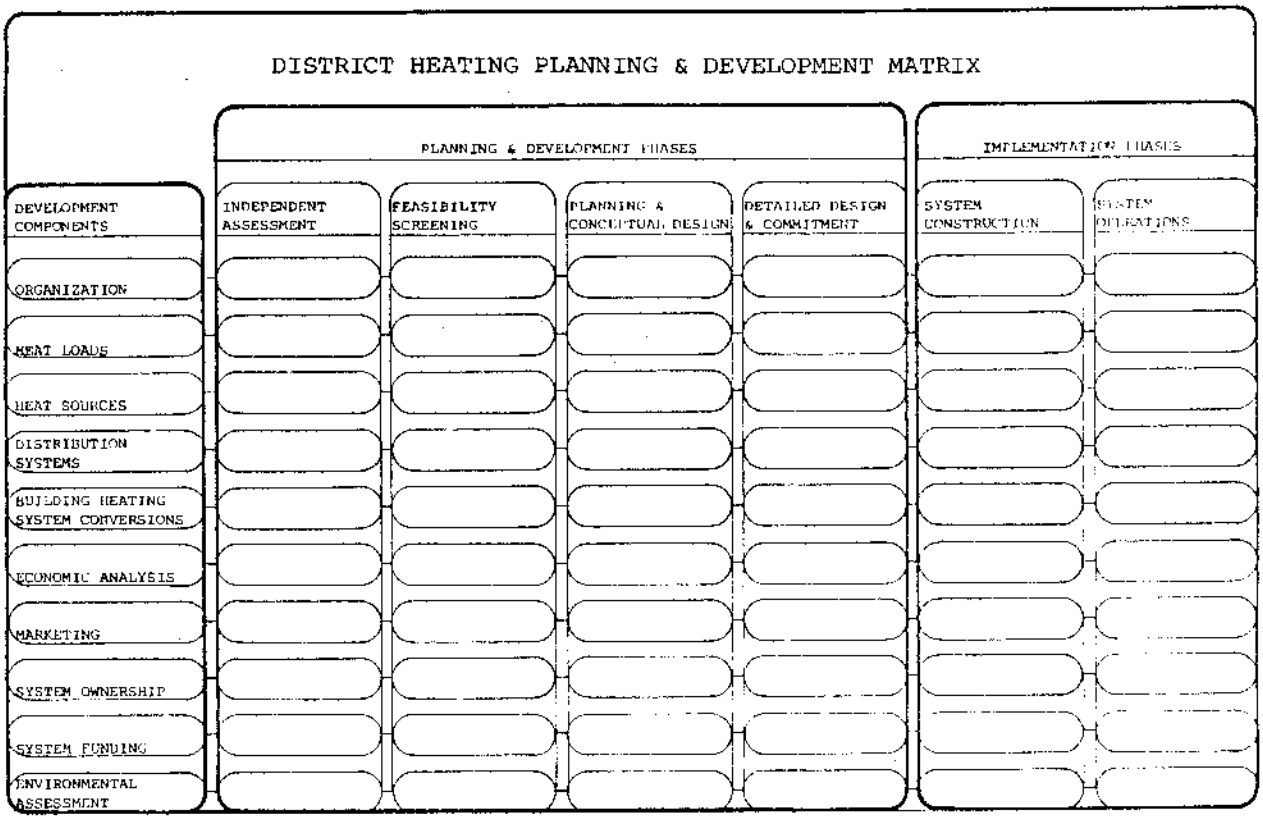
Section 6.0 OWNERSHIP AND OPERATIONAL CONTROL OPTIONS reviews in detail the various district heating system ownership options available to communities. It describes the primary criteria for selecting the most suitable alternative as well as additional considerations regarding the ownership options for the separate system components. With this basic information, communities may begin to assess the best option for their particular circumstances.

Section 7.0 SYSTEM FUNDING STRATEGIES summarizes the various funding sources for district heating development. It examines in detail the more promising funding options available for each development phase. With this information, communities may begin planning their own funding strategies and defining the detailed requirements of the proposed funding sources.

Section 8.0 APPENDICES is a collection of materials applicable to community planning and development of district heating systems.

The preparation of this Guidebook occurs at a time when significant events in district heating are underway both in Minnesota and across the nation. The results of district heating development projects only now in the planning and construction phases will add greatly to the current base of knowledge. New legislation, changed tax rulings, revised policies, fuel price changes, and the experience gained on completed district heating projects may significantly alter the accuracy of portions of the material contained herein, especially the information concerning the most crucial aspects of district heating development, the ownership and funding questions.

1.0 DISTRICT HEATING DEVELOPMENT: AN OVERVIEW



This section provides a basic overall understanding of the district heating development process. It introduces the planning and development process, the sequential phases of development, and the components which represent the principal tasks of development activity.

1.1 District Heating Development

The development process is represented graphically in the preceding "District Heating Planning and Development Matrix". The phases, or time stages, of district heating development are listed across the top of the matrix.

Each development phase has a purpose:

SYSTEM PLANNING AND DEVELOPMENT

- Independent Assessment - a no-cost initial evaluation of the favorability of local conditions for district heating
- Feasibility Screening - a preliminary assessment of the feasibility of a proposed district heating system
- Planning and Conceptual Design - preliminary project design and development and feasibility assessment
- Detailed Design and User Commitment - completion of detailed system design and planning; final assessment of development feasibility; commitment to system construction and operation

SYSTEM IMPLEMENTATION

- System Construction - installation and physical implementation of system design and plans
- System Operations - start up and operation of district heating system; demonstrates successful completion of district heating development process

The components of development, those activities which represent the principal areas of work effort in the development process, are listed down the left side.

Each of these components is crucial to the successful completion of a district heating development project. Section 1.2 Development Components below provides a definition and discussion of each component.

The development phases organize the tasks of the separate components into groups of tasks that need to occur concurrently, or within the same relative time period. In this way, all of the components are developed in a consistent and incremental fashion.

This incremental development process contains interim feasibility checkpoints at the end of the first four phases. With each succeeding phase, the information, resources, commitment required, and the test of feasibility become more specific.

This Guidebook concentrates on the first three phases: INDEPENDENT ASSESSMENT; FEASIBILITY SCREENING, and PLANNING AND CONCEPTUAL DESIGN. The development activities for each of these three phases are reviewed in detail in the sections bearing their name.

The development of a community district heating system involves many participants having many different roles, responsibilities, and interests. A district heating system requires customers--thermal energy users. It requires a source of heat and the piping distribution system to deliver the thermal energy to the end users. Someone must develop, own, and operate the district heating system, and there must be some investors to finance the system's development and construction.

Each prospective participant possesses their own separate, and often conflicting, objectives and interests and will take part only if their interests are met. These interests establish what must be accomplished for a district heating development project to be successfully completed. District heating development, therefore, requires a cooperative effort to achieve the mutual satisfaction of all the participants.

1.2 Development Components

Below are introductory descriptions of each development component. Each of these components each has a sequence of tasks or pertinent considerations that carry through all or part of the development process and are individually discussed in the development phase in which they occur. The successful completion of these components - the principal work activities - is crucial to a district heating development project.

1.2.1 Organization

The organization component includes consideration of project management, the participants, the planning and implementation of the organization and commitment of resources for development.

Project management should be the responsibility of the entity that will likely own and operate a completed district heating system. Until that entity is identified, however, project management responsibilities may temporarily reside with the proponent group or with the municipality or some municipally-delegated committee or commission.

Solid project management experience is a prerequisite for undertaking district heating development. Knowledge or exposure to district heating must be developed, acquired, or retained before proceeding far into the development process. The project manager will be required to organize and coordinate a multitude of activities:

- engineering studies and design
- economic feasibility analysis
- marketing studies
- financial/investment analysis
- public relations/information dissemination
- feasibility studies

Community district heating affects many people and organizations. Ideally they all should have the opportunity to participate in its planning and development. The diverse local interests should be heard and represented. Creation of an advisory committee with broad representation is effective to hear all sides may be existing groups or committees. Within the community there may already exist a group or groups that have this representation.

General community participation is desirable to the extent that the general public is affected by the project. This impact may be direct as district heating system users/customers. It may be less direct as future system users or as tax-paying guarantors of municipal financing. Although often not directly involved, the general public will certainly be directly affected by district heating construction activity and disruption.

Local municipal government support and cooperation is important if district heating development is to be successful. It is desirable that local government take an active--if not the lead--role in the development process.

Community district heating development also requires significant specialized knowledge and expertise in areas that communities may not have locally. The selection and use of appropriate consultants and resources will have a major impact on the developmnent process.

Before a district heating system returns its first operating revenues, very substantial investments of planning resources and construction capital must be made. This investment or commitment is made gradually during the planning and development process. The organization of the development process must be thorough and methodical to ensure that these commitments to future benefits are wisely based in reality. Making these commitments requires the community and the separate participants in the development process to take the risk that the system will be feasible and will be implemented.

1.2.2 Heat Loads

The heat load for a building is the amount of heat needed to keep the building warm on the coldest day. The heat load must be known when conventional heating systems are installed in order to properly size the furnace. A typical residence, for example, may require about 100,000 BTU/Hr. (British Thermal Unit per hour) or, equivalently, 30 KW (kilowatts) of heat.

The heat load for a district heating system is comprised of total individual heat loads of those prospective end users such as the space heating needs of residential, commercial, industrial buildings, and agricultural and industrial plants process needs.

1.2.2 Heat Sources

Heat sources are boilers which use the combustion of various types of fuels to produce energy as heat used in the system. Although such combustion devices most likely would be used in new district heating systems, almost any energy source may be used for the relatively low temperatures required in hot water district heating. It is possible to use geothermal energy, solar energy, nuclear energy and varieties of so-called waste energy for district heating.

1.2.4 Distribution Systems

The distribution system is comprised of the pipes that carry heat from the central heat source to the individual buildings (heat loads).

There are two common heat distribution systems - steam and water. In a steam system heat is supplied to the buildings by the condensation of the steam. The condensate may be returned through a second pipe or disposed of through the sewers. Both types are used today.

Steam may be useful in some industrial processes and is often attractive from the building owners viewpoint because in-building equipment can be cheaper. However, on a system basis, steam distribution is being superceded by hot water.

Hot water distribution systems are similar to the hot water heating systems found in many homes. One pipe carries hot water from the heat source (furnace) to the individual buildings where it is used to heat radiators. It is then returned through a second pipe to the heat source to be reheated and reused.

1.2.5 Building Heating System Conversions

The conversion is the addition, modification, renovation, and hookup of building mechanical, electrical, and control systems to make use of district heating thermal energy. To use thermal energy from a district heating system, a building may be equipped with a heat exchanger. It transfers thermal energy from the distribution medium--hot water or

steam--to the medium used internally--most likely hot water, steam, or forced air.

1.2.6 Marketing

The marketing component of the development process includes two elements: (1) promoting the general concept of district heating and (2) attracting potential customers.

General public support is often necessary for planning and implemention. It is important that the public have information on costs, benefits, and potential barriers to make proper decisions about district heating. It is essential that the community to make informed decisions based on a proper understanding of the concept of district heating, its benefits, its costs, and potential barriers are necessary for the community to make informed decisions.

Secondly, successful and efficient district heating systems depend upon attracting customers with sufficient heat loads. The marketing component involves the activities during each phase intended to attract and obtain commitments from potential customers.

1.2.7 System Ownership

This component considers who will own and operate the proposed district heating system or parts ~~thereof~~. It involves determining who may be willing to accept the responsibility of ownership or operation, who can obtain needed funding, and who can operate the system most efficiently for the benefit of customers and the general community.

Section 6.0 Ownership and Operational Control Options describes in detail the numerous available considerations and choices.

1.2.8 System Funding

This component determines appropriate funding for the planning and implementation of a district heating system. Funds are needed for each phase, ranging from relatively small amounts for the feasibility screening phase and increasing to the substantial investment needed for the construction of a system.

Section 7.0 Systems Funding Strategies outlines both funding sources and their application to the various development phases.

1.2.9 Economic Analysis

The feasibility of a district heating development project is largely determined by its economic feasibility. The economic analysis required for district heating feasibility is a cost-benefit comparison with the

more common alternative sources of heating buildings and domestic water and providing process heat. Favorable long-term cost benefits are essential for district heating to be a viable investment. The ability to securing financing and successful market for the system may necessitate a favorable cost-benefit analysis for the short-term as well.

The cost of heat provided from a district heating system is comprised of heat source energy costs, system construction costs, conversion costs, financing charges, and operating expenses. These costs are determined more exactly during the planning and development process. This makes comparisons possible with the projected costs of alternate heat sources. (Although cost comparisons will always require price projections which are speculative, reasonable assumptions can be made to estimate the cost-benefits.

This analysis must be done for the system as a whole and individually for the various areas being considered for inclusion within the system.

Other potential costs and benefits, such as dependability, safety, and impact on economic development and revitalization, also require consideration.

1.2.10 Environmental Assessment

Although district heating is generally recognized as an environmentally beneficial technology, each district heating development project should be cleared through normal regulatory channels to assess the environmental impact.

The environmental impact of a district heating project is primarily related to construction activities and air quality. The construction impact depends on heat source siting, fuel handling, and excavation. The impact on air quality is more substantial.

Normally, efficient of district heating will mean reduced fuel use especially in communities where there is a significant amount of electric heating. District heating can often mean a change in the type of emissions, especially since district heating systems can use a variety of fuels. For example, community with primarily natural gas heating converting to a coal fired district heating system may increase the emissions of some environmentally objectionable products.

Conversion from gas and oil heating to coal based district heating has not been objectional, even in an environmental non-attainment area such as St. Paul. The reasons for this attitude are the recognized benefits from 1) single reasons for this attitude are the benefits recognized by 1) single source emissions control 2) higher altitude disbursement of emissions, and 3) reduced thermal rejection to the environment. Unless they have exceptional characteristics, district heating projects will not be hampered by environmental obstacles.

The State of Minnesota has simplified the environmental approval process.

The environmental assessment worksheet (EAW) was developed to quickly determine whether or not the longer environment impact statement (EIS) is necessary. The advantage of the EAW is that it should take less than six months. An EIS clearance can often take a year or more. With most district heating projects, the EAW will substantiate there is no need for an EIS.

A sample EAW which includes the information necessary for submittal is included in the Appendices. Persons needing assistance should contact the Minnesota Energy Agency. It is recommended that MEA be contacted prior to filling a EAW, since pending legislation may affect the environmental assessment process.

1.3 Feasibility

Feasibility assessment is the determination of whether design concepts result in a system which makes sense technically, is financially possible and will provide cost or other benefits to the potential users and the general community. Project feasibility must be reevaluated during each phase of the planning and implementation process as more detailed information is obtained regarding heat loads, construction and operating costs, users interest and commitment, funding availability and terms, and other factors affecting the likely success of the system.

Although feasibility assessment is continuous throughout the entire planning process, there are several formal checkpoints:

1. INDEPENDENT ASSESSMENT. Feasibility is evaluated upon completion of this phase.

2. FEASIBILITY SCREENING. The second test is based upon estimated capital costs and an initial evaluation of development options and alternatives.

3. PLANNING AND CONCEPTUAL DESIGN. Feasibility assessment is based on detailed cost estimates and project-specific decisions and assumptions.

4. DETAILED DESIGN AND USER COMMITMENT. If a project is found to be feasible here (based on final detailed project cost estimates and with nearly complete project definition), bids may be solicited and contracts awarded for systems construction.

There are several important factors to consider when determining feasibility:

- Feasibility is relative to the current time frame. A project which is not now feasible may indeed become feasible in the future time because of changing factors. Conversely, current

feasibility does not guarantee future success.

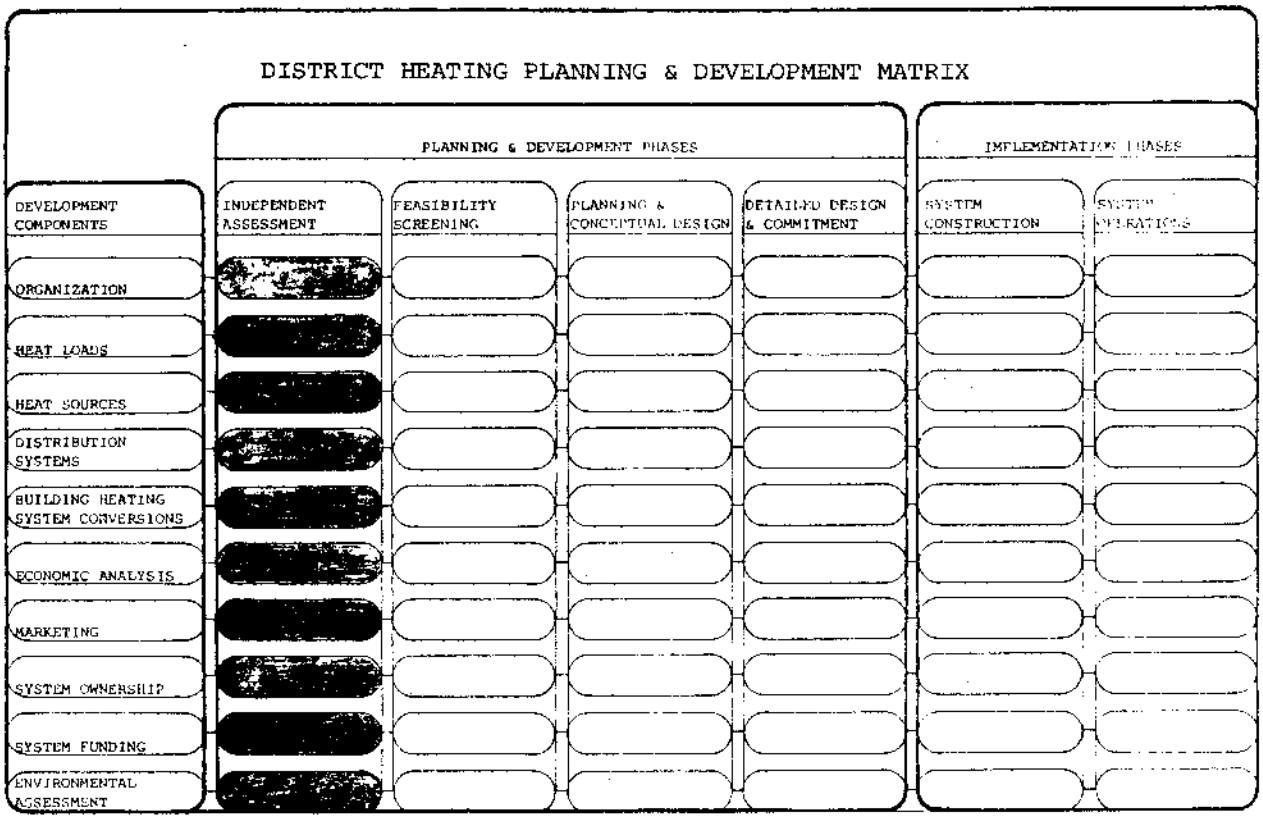
- Determination of feasibility will be strongly dependent upon forecasts for such factors as fuel costs, interest rates, energy usage and conservation rates, and alternative energy costs and availability, as well as estimates of capital expenditures for construction. Forecasts will never be exact. Thus, developers must choose to accept the risk that district heating may not provide energy at lower cost than any present or future technology.

- Technical feasibility is not a problem. Any Minnesota community could install a working district heating system with the proper engineering expertise.

The question of feasibility also concerns matters beyond economic and technical questions such as long-term goals related to the construction of the district heating system and community and cultural factors. Community services often are extended to members of the community for reasons other than economic gain. District heating service is likely to be viewed in the same manner. The community should consider both the positive and negative aspects that district heating might bring to the community beyond the narrow prospects for short-term economic considerations.

The overall question for a community-based system will quite naturally come down to the common good of the community. It is the question that must be considered..

2.0 INDEPENDENT ASSESSMENT



With a basic understanding of DISTRICT HEATING DEVELOPMENT, a community may now begin planning a district heating project.

Section 2.0 INDEPENDENT ASSESSMENT describes the initiating steps a community may make and what considerations are important for each development component at this stage.

A useful tool, the Independent Assessment Questionnaire, has been included to assist communities with this task.

2.1 What Is Independent Assessment?

INDEPENDENT ASSESSMENT is a general and non-technical survey of the community characteristics and local conditions that affect district heating development. It is conducted locally using only community resources and personnel.

INDEPENDENT ASSESSMENT will help community leaders gain a further understanding of district heating as it relates to their own community. It will give a preliminary indication of whether it is practical to proceed with the development process.

The only cost to the community for this independent assessment is the minimal donated time of the individuals and organizations that take part. It can be accomplished within a minimal time span, comfortably in less than one month. It requires no professional consultation.

2.2 Methodology

INDEPENDENT ASSESSMENT consists of two steps:

1. Determine whether local conditions and characteristics favor district heating development.

2. Seek a local commitment for the continued investigation of district heating.

The first step consists of evaluating the local factors that significantly affect project feasibility. Even without knowledge of or experience with district heating, a community may make this independent assessment using this Guidebook. The development matrix leading this Section identifies important factors for consideration. Further explanation is found in Section 2.3 Development Components. A useful tool - the Independent Assessment Questionnaire - may be found in Section 2.4.

One way to complete this initial evaluation is to assemble a group of knowledgeable and influential members of the community to collectively address the Independent Assessment Questionnaire. This group should represent the spectrum of community interests and include at least those people that are likely to be directly affected by district heating development.

This meeting should be used to familiarize community leaders with district heating development and its potential, to generate discussion and interest, and to assess the possibility of local district heating development. Arrange for a speaker that understands district heating. Provide descriptive handout material. Use the Independent Assessment Questionnaire and Section 2.3 to discuss local development possibilities and benefits. Favorable reaction from these people is critical to further development.

The second step of INDEPENDENT ASSESSMENT may also be initiated at this meeting. The next phase, FEASIBILITY SCREENING, requires committing both financial and personnel resources. Official municipal endorsement may also be required. It is important to know how much interest and support for this project exists now for this project.

Solid ground work has been laid for further consideration of district heating if there is interest in district heating.

2.3 Development Components

During INDEPENDENT ASSESSMENT, information gathering is begun. This initial information will be speculative or "soft", (without substantial documentation) but it will be pertinent to the decision-making process. The information is useful at this stage, however, recognizing that it will be subject to future verification.

The following sections outline considerations for each component. (A basic description and general discussion of each development component is found in Section 1.2).

2.3.1 Organization

No formal organization is necessary to complete INDEPENDENT ASSESSMENT. It is essential, however, to bring together for discussion all the diverse local community groups, organizations, and interests that may be affected by district heating development. This broad spectrum is necessary for a proper assessment of local interest and conditions.

Participants should include district heating proponents, elected municipal officials, private or municipal utility representatives, prospective major customers, business or chamber of commerce representatives, municipal government staff, interested professionals, community leaders, labor and contractor officials, members of the financial community, developers, interested citizens and persons from other interested groups.

Leadership and management of this initial phase will likely fall on the district heating proponents. If a community already has an energy advisory committee, it may appropriately make this initial assessment.

The planning group should also consider the most appropriate organizational structure for the FEASIBILITY SCREENING and PLANNING AND CONCEPTUAL DESIGN phases of the development process. The responsibility for these phases may be an organization which potentially may own or operate the system.

2.3.2 Heat Loads

A district heating system requires customers. Therefore, it is important here to identify the large heat loads that represent major potential customers. These include larger industries, hospitals, schools and larger businesses. These larger loads will have more impact on system feasibility than the numerous smaller loads and therefore should be singled out for greater attention.

Both existing and planned future buildings should be considered. Buildings requiring retrofit to connection with district heating should not be excluded.

Planned new construction should receive particular consideration since building equipment may be designed specifically for connection to a district heating system.

2.3.3 Heat Sources

A district heating system requires one or more primary generating sources for the thermal energy it distributes to its customers. The sources may be either existing systems retrofitted to supply thermal energy or they may be new plants built specifically for district heating.

Currently, the most promising heat source for a community district heating system is an existing coal-fired electrical generating plant retrofitted to extract thermal energy for the district heating system. Some excess or unused capacity in the generating plant is necessary, however, for its use.

Other existing or planned heat sources in the community such as under-utilized boiler capacity or incinerators may also be possible district heating system heat sources.

2.3.4 Distribution Systems

The network of pipes that distributes the thermal energy from the central heat source to the district heating customers is usually the single most expensive part of the system. A greater concentration of customers favors district heating development by reducing distribution costs. The location of the heat load in relation to the heat source affects the requirements for transmission and therefore, also affects distribution costs.

The presence of one or more major users also favors feasibility, since it represents fewer connections to a system for a comparable load (less cost).

One final consideration is physical and geographical barriers. Obstacles encountered in underground pipe burial will increase the cost of installation. Substantial rock, ground water, or other utilities hamper construction. Physical features such as rivers and lakes present obstacles that are expensive to cross or go around. Right-of-ways and easements for major highways and railroads also present considerable difficulties in crossing.

2.3.5 Building Heating System Conversions

During INDEPENDENT ASSESSMENT, it is too early to investigate individual buildings. It is possible, however, to note any significant general patterns in building heating systems - their type, age or condition.

The need to replace individual furnaces, for example, may be eliminated by switching to district heating. The need to modernize internal building heat distribution systems reduces the total additional cost of district heating implementation. If a major potential district heating customer plans to upgrade an antiquated system, it may be even more economically attractive to connect to a district heating system.

If an existing district heating system is deteriorating or may be abandoned soon, the option of a modern or thoroughly refurbished system may be more economical than installing and operating many individual boilers and furnaces.

2.3.6 Marketing

During INDEPENDENT ASSESSMENT two factors should be considered:

1. the community's knowledge of and interest in establishing a district heating system; and

2. the capability of a district heating system to provide heating for a lower cost.

The community should be aware that a district heating system is under consideration. Therefore, it is important that all potentially affected interests become involved at this early stage.

Particular emphasis should be placed upon major potential users who tend to be most concerned about energy costs and may already be investigating methods of containing those costs. The participation of one major customer or decision maker may be the difference between failure and success in implementing a community district heating system.

Successful future marketing of a district heating system will depend upon the system's capability to provide heat at a lower cost than existing or potential alternative sources of energy. Therefore, existing energy sources used by the community and potential alternative energy sources should be identified. Cost projections for current energy sources can be reviewed to determine the likelihood of a district heating system providing cost benefits over a short term or a long term.

2.3.7 System Ownership

Most communities can consider several options for the ownership and/or operational control of a district heating system. During INDEPENDENT ASSESSMENT it is not necessary to make a final choice but it is appropriate to identify prime candidates.

If there is an existing district heating system or if the likely heat source is owned or operated by a municipal or private utility, the group should explore the willingness and the desirability of that utility or system to own or operate the proposed system as well. Their involvement is most advantageous.

More information about ownership options is found in Section 6.0.

2.3.8 System Funding

The primary focus of the funding activities during INDEPENDENT ASSESSMENT will be on determining the types and amount of funding, staffing, and technical assistance for FEASIBILITY SCREENING. The following potential funding sources may be explored:

- Federal Grants. It is doubtful that any federal Department of Energy grant funds will be available for planning district heating projects. It may, however, be possible to use other federal grant funds in the planning process. These include Housing and Urban Development (HUD) community development block grants, HUD urban development action grants (UDAG), and if the agency is still in existence and funded, economic development or public works grants from the Economic Development Administration.

- State Grants. The State of Minnesota has $200,000 for district heating preliminary planning available to municipalities in fiscal 1982. The amount of each grant is limited to 90 percent of eligible planning costs and must not exceed $20,000.

- Special Governmental Funds. A review should be made of any special governmental funds such as Iron Range Resources and Rehabilitation Board (IRRRB) grants which may be available to communities located in proximity to taconite mining operations.

- Municipal. Funds and staff time may be provided by a city or its public utilities commission.

- Foundations. Grants may be available from some private foundations for district heating system planning. In particular, locally based foundations including those related to local industries, should be contacted.

- Potential Users. Major potential users can be contacted to determine their willingness to provide funds or staff time to assist in the planning process.

- Business and Community Groups. Business and community groups such as the Chamber of Commerce, downtown councils, social service clubs, and other community groups may be a potential source of funding for the planning process.

In addition to funding sources, staff time and technical assistance may be available from a variety of sources including the Minnesota Energy Agency, regional planning commissions, private or municipally owned utilities, the city, other cities operating district heating systems, major potential users, local industries, universities, colleges, or Vo-Tech schools, or the staffs of community organizations.

Additional information about system funding is found in Section 7.0.

2.3.9 Economic Analysis

An early economic indicator of district heating feasibility for a community is a significant existing or projected price disparity between the predominant fuels or energy forms currently used and the fuels anticipated for use in a proposed district heating system. Such a price disparity would result in significant operational cost savings arising from fuel substitution alone, without considering the additional opportunities for improved energy conservation measures.

A local fuel source which is economically competitive, such as waste products from an industrial process or the incineration of solid waste, may also enhance the prospects for district heating development. To be viable, these energy sources should already have demonstrated their own technical and financial feasibility.

2.4 Independent Assessment Questionnaire

Now that you are familiar with the major considerations for the district heating components, you can complete the Independent Assessment Questionnaire.

This questionnaire can be used in the community, without professional assistance, to determine if local conditions favor a district heating system. This is a good first step to complete before spending a lot of time and money for further planning and development.

A broad cross-section of community leaders and citizens must complete this questionnaire jointly, including leaders from municipal, community, financial, and business interests.

After completing the questionnaire, total the yes and no responses. If there are ten or more positive responses, the community is justified in proceeding with development. If there are fewer positive responses, district heating development is less promising and perhaps should not be pursued. (This is, however, a subjective response and perhaps the interest and discussion generated may be of greater value than the numerical response.)

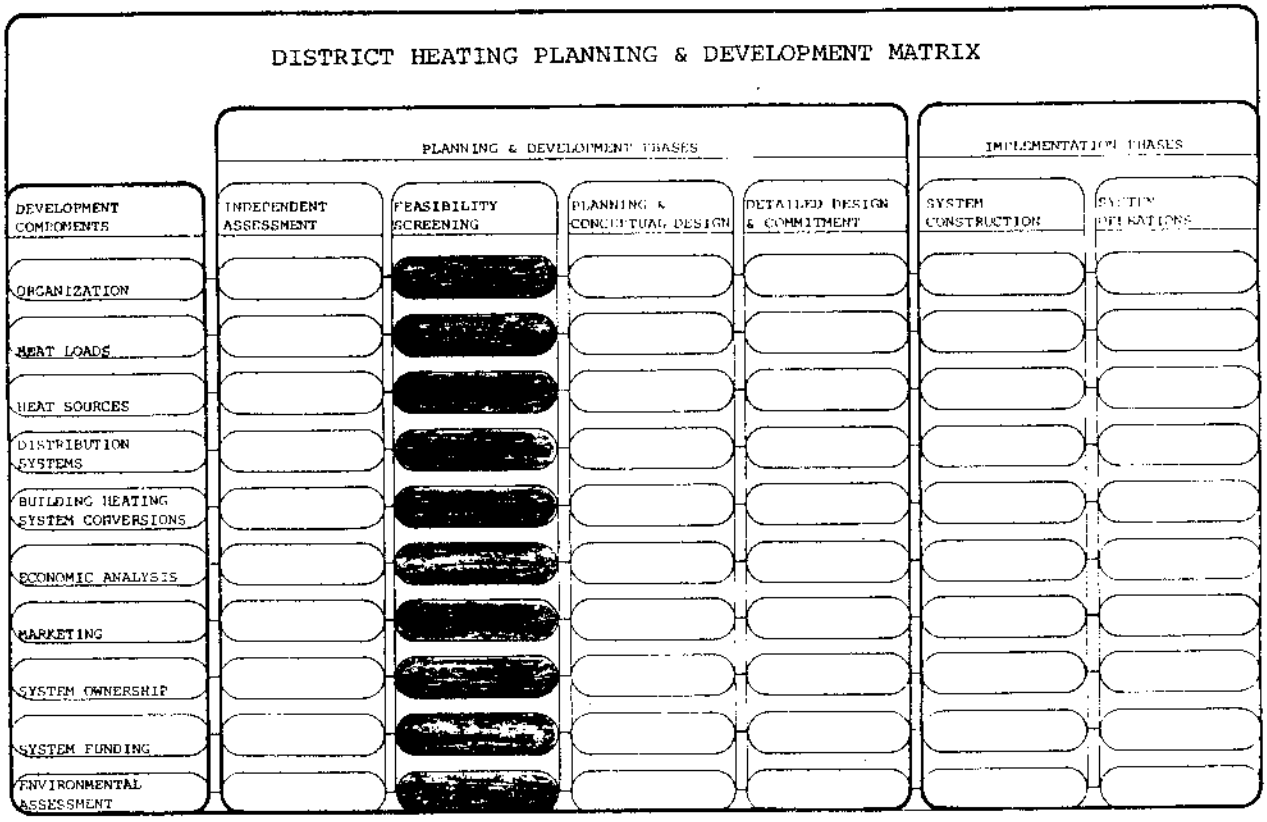
INDEPENDENT ASSESSMENT QUESTIONNAIRE

		MORE FAVORABLE	LESS FAVORABLE
1.	Does your community have one or more large users of thermal energy for space heating, water heating or processing?	Yes _____	No _____
2.	Is there major new construction or development planned or underway in your community?	Yes _____	No _____
3.	Is there an electrical generating plant in or near your community that offers the opportunity for cogeneration of electrical energy and thermal energy for district heating?	Yes _____	No _____
4.	Are there existing or planned heat sources in or near the community that may be possible sources of district heating thermal energy?	Yes _____	No _____
5.	Do any existing or planned local heat sources have excess or potential excess capacity to dedicate to local district heating thermal energy production?	Yes _____	No _____
6.	Are most of the major potential customers and large thermal energy users located close together?	Yes _____	No _____
7.	Is there a single or small group of thermal energy users that comprise a significant proportion of the community's total thermal energy load?	Yes _____	No _____
8.	Is the primary heat source located within one mile of the major concentrations of potential customers?	Yes _____	No _____
9.	Are there any significant physical or geographical barriers that divide or present difficulties in serving the entire potential heat load?	Yes _____	No _____

10. Are there major thermal energy users that are planning to replace and/or upgrade their internal heating systems in the near future?	Yes _____	No _____
11. Is there an existing deteriorating district heating system in the community that may be abandoned?	Yes _____	No _____
12. Are community officials and other influential local people interested in district heating? Do they support it?	Yes _____	No _____
13. Does a possible district heating system permit the substitution of a significantly lower cost for higher priced, currently-used fuels?	Yes _____	No _____
14. Do major thermal energy users in the community know about district heating and understand its comparative advantages?	Yes _____	No _____
15. Does the community have an existing district heating company or utility?	Yes _____	No _____
16. Does the community operate a municipal energy utility system?	Yes _____	No _____
17. Is there private developer interest in district heating development?	Yes _____	No _____
18. Does the community anticipate other major capital investment projects that might limit the capital availability for district heating development?	No _____	Yes_____
19. Is the municipal government readily able to raise the capital necessary for district heating development either through its bonding capability or its tax base?	Yes _____	No _____
20. Does the community have an economically viable and technically feasible alternative energy source?	Yes _____	No _____

TOTAL NUMBER OF RESPONSES	MORE FAVORABLE	LESS FAVORABLE
	_____	_____

3.0 FEASIBILITY SCREENING



Having determined through INDEPENDENT ASSESSMENT that local conditions appear favorable for district heating, proponents can now proceed to FEASIBILITY SCREENING. This phase requires a more thorough examination of the factors previously explored.

Section 3.0 FEASIBILITY SCREENING provides a step-by-step method for roughly estimating the capital investment costs of a district heating system. This estimate is initial since capital costs represent such a major initial investment.

This section also outlines how a community can investigate each development component.

3.1 What Is Feasibility Screening?

The FEASIBILITY SCREENING phase is a low-cost overall review of community considerations and their impact on district heating development. Cost estimates are developed using rule-of-thumb methods. These estimates are extremely useful during this phase, but should not be used after this step because they are only approximations.

Options and alternatives are identified. Factors for a successful district heating project are more fully explained.

The purpose of this phase is to determine whether a project is feasible as early as possible. The project will meet the criteria if:

1. the estimated capital costs are comparable to those of other Minnesota district heating projects; and

2. there are no major obstacles that would seriously limit or prevent the system's success.

Although the evaluation during this phase is qualified and relative, it is important. This quick, inexpensive, and comparative measure of feasibility will add substance to requests for resources to continue the planning and development of the district heating system.

3.2 Screening Methodology

The methodology for FEASIBILITY SCREENING consists of two parts. The first part compares economics of a proposed district heating system to systems in other Minnesota communities. The second part is the definition of the viable options, alternatives, and opportunities for system ownership and funding. The process will also identify options that are not possible plus other potential obstacles and constraints).

The following tasks are required to arrive at capital costs estimates:

1. Heat loads - Estimate individual building heat load requirements. Identify on a map the geographical areas of greatest heat load concentration or highest heat load density.

2. Heat sources - Identify potential primary heat sources. Determine the willingness of the sources' owners to participate. Estimate the capital costs of expanding, renovating, and converting these sources.

3. Balancing - Define several geographical service areas with a total heat load that is approximately equal to the capacity of the proposed heat sources.

4. Distribution systems - Develop capital cost estimates for piping to distribute thermal energy to end users.

5. Building heating system conversions - Develop capital cost estimates for the end user building conversions.

6. Economic analysis - Add together the separate component cost estimates for the total system cost. Compare with the range of equivalent values for other communities.

7. Fuel source substitution - Identify potential savings and problems for substituting a more abundant and less costly fuel source for one that is scarce and more expensive.

The following areas are reviewed in the second part of FEASIBILITY SCREENING:

1. System ownership - Determine if there is a logical ownership selection. Identify the realistic ownership alternatives.

2. System funding - Identify funding options for system construction. Identify and secure funding sources for system planning.

3. Marketing - Determine whether major users are willing and interested in participation. Assess the interest of the entire community and of potential user groups.

4. Organization - Define the group or organization that will assume project management responsibilities, either on a permanent or temporary basis. Define and implement a plan to ensure community participation for at least those persons and organizations that are directly affected by this district heating development. Develop and implement a public information program.

5. Environmental analysis - Identify potential difficulties or constraints to system development.

3.3 Development Components

The following sections contain explanations of the local considerations of greatest importance for each component in this phase and instructions for specific actions your community or proponent group should take to complete the FEASIBILITY SCREENING evaluation.

3.3.1 Organization

To complete FEASIBILITY SCREENING and subsequent phases, project development management responsibilities should be assumed by the logical future district heating system owner/operator or interest, such as an existing private or municipal utility. If there are several

options, either the municipal government or a municipally-designated agency or commission may be the most appropriate group to temporarily assume project management responsibility until an ownership selection is made.

The following groups and interests should be involved in this phase: the local adhoc group or other public or private entities assuming responsibility for local planning; local engineering, economic, financial, and legal expertise; local utilities, and major potential customers.

Initial project management responsibilities consist of identifying the organizational and planning requirements for FEASIBILITY SCREENING and outlining requirements for following development phases. Factors to consider include budget, schedule, resource availability, work scope, and task assignments.

Resources to support the initial work efforts must be secured. It is important at this stage to secure a formal commitment of interest and support from municipal government in the form of an official resolution or order.

The estimated time for FEASIBILITY SCREENING is one to six months. Estimated costs range from $5,000-$30,000 depending on the size of the community and the complexity of local conditions. This would include the value of donated and volunteer time.

3.3.2 Heat Sources

Sources of thermal energy for district heating systems may already exist in your community or they may have to be constructed. Heat sources are needed for the prime heat load, parking of demand, and emergency standby.

3.3.2.1 Existing Sources Existing sources can serve two purposes in a district heating system. First, they can provide the base load or prime source for the heating. Second, they can provide peak or standby capacity during periods of high heat demand or outages on the base unit.

Any existing power plant or large consumer of fuel (relative to the overall size of the community) should be considered as a potential prime load heat source. The type of plants to consider include:

- Electrical generating plant. Any power plant within 5 miles of the community should be considered if it is coal or wood fired. This may be the most attractive source.

- Oil fired power plants. A number of these power plants have operated as district heating sources in Minnesota, primarily as peak power suppliers. A community with an existing diesel or dual fuel power plant might consider this option. Gas turbine

plants should not be considered. Normally, however, diesel, dual fuel and gas turbine plants, will not be attractive sources due to the cost and/or availability of their fuel.

- Coal fired plants. There are few usable coal fired heat sources in Minnesota other than electrical generating plants and existing district heating plants. However, any active coal fired device should be considered due to its desirable fuel economics.

  The most attractive existing heat source for the prime load will often be a coal-fired electrical power plant. An estimate of the potential thermal power available from existing coal-fired electrical power plant's can be made by assuming it to be equal to the plants' rated electrical output.

  The advantages of an existing coal-fired electrical plants are unlikely to be duplicated by other exiting sources. These include fuel flexibility and a utility design emphasizing reliable continuous service. Reliability is an important consideration for a potential heat source.

  At this level of investigation it is safe to assume that any coal fired power plant is a technically feasible source for district heating.

The best information regarding potential heat sources comes from the owners and/or operators of the plant. These individuals have information on the overall size, condition, fuel costs, and other matters.

General types of information to be obtained from owners/operators include:

- Size
  - KW electrical output
  - Lbs/hr. steaming capacity
  - Fuel consumption
    - -- Max/hour
    - -- Annual
- Type of Fuel Burned Now and Before
  - Emission regulation status
  - Future plans
  - Expected lifetime
  - Excess capacity

With the cooperation of the owner/ operators, it should be possible to estimate costs for conversion. Without their cooperation, only rough estimates may be made, since every plant will require specific evaluation. Recent evaluations of power plants of different types in

Minnesota have shown a range of costs from $20 to $50 per kilowatt of heating capacity for conversion. These numbers may be used with the understanding that specific investigations should take precedence.

Almost any existing heat sources within the service area can be used for peak standby: the boilers in a hospital, school or other large buildings may be adapted as peak or standby units. The type of fuel which they use does not matter as long as availability is guaranteed. These boilers do not need to be investigated in detail at this time.

The Minnesota Energy Agency can provide a list of large combustion devices which may be suitable as heat sources (the "N.E.D.S." data file). If neighboring counties are close, information should be requested from them. For potential smaller local sources, the simplest check is to look for stacks.

Other possible heat sources for district heating systems include:

- Existing underutilized boilers (e.g., old creameries)--these can be quantified by the available capacity and fuel used (usable) as well as physical descriptions.

- Industrial boilers--difficult to quantify due to the process, their sometimes proprietary nature, seasonal variations, and too low temperatures.

Important factors to consider regarding potential heat sources are:

- Thermal Requirements:

  - Medium (steam, water?)
  - Temperature
  - Peak load
  - Annual consumption
  - Peak supply
  - Fuel
  - Reject conditions
    -- Medium
    -- Temperature
  - Daily cycle

- Ideal situations might be a plant with:

  - Coal/wood fired (low cost fuel) boiler
  - Summer use only (as either a load or a source this type of cycle will improve economics as a load and provide capacity for heating as a source
  - Peak supply > load-excess capacity
  - ~ 200-95° water as a load
  - Reject energy ~ 10 psi steam (as a source)

Seasonal variations can be beneficial or detrimental depending upon the situation. These sources should be investigated and considered potential consumers as well as suppliers.

3.3.2.2 New Sources It is acceptable to use generic cost figures for new sources realizing that inflation and local building conditions will affect these costs. New oil and gas fired boilers will probably cost approximately $10 per pound per hour of steaming capacity. Small coal and wood fired boilers will probably cost between $50 and $100 per pound per hour of steaming capacity, while large coal fired units may cost between $100 and $125 per pound per hour of steaming capacity. (All of these costs are in 1981 dollars.)

Federal new source performance standards for emissions take effect at 250,000 pounds per hour of steaming capacity. Units of this size or units planned for this size or larger will require significantly more complex and expensive emission control equipment. While economies of scale would normally dictate lower costs for larger units, it is likely that the smaller coal and wood fired units will actually be less expensive than the larger units. All values may be multiplied by 3.413 for the cost per kilowatt installed. The costs of these units do not reflect any electrical generating capacity (these are not cogenerating heat sources).

The decision to consider cogeneration is essentially an economic one, depending on the cost of reducing electricity and the local market for electricity. It is recommended that this consideration be deferred until the next phase since it is unlikely that economic benefits from cogeneration will be of a magnitude to significantly alter the feasibility of the overall project.

3.3.3 Heat Loads

The thermal power requirements, or building heat loads, of ~~the end~~ users must be known to determine all subsequent technical and economic calculations. The maximum thermal power requirements of the users, (the rate energy is used during the period of maximum use) must be known in order to size both the piping system and the heat sources.

Building loads may be approximated from building floor areas. Structural base map showing the outlines of the building perimeters, often available from the building or planning departments or the assessor's office, may be used to calculate heat loads. Measure the actual areas from the map and, with information on the number of heated stories of each building, compute the heated floor area. Multiply this figure by ten watts per square foot.

For example, 2,000 square foot home (excluding the basement) would have an estimated heat load of 2,000 square feet x 10 watts per square foot or 20,000 watts (20 KW).

Maximum thermal power requirements for end users may also be arrived at through two other basic, but more rigorous, paths. The first way is to analyze past energy consumption records. The second way is by analyzing the building envelope itself (walls, roof, doors, windows, etc.).

If you use the first method, you must obtain energy consumption records from current suppliers or building operators by interviews or questionnaires. These records include gas bills, electric bills and oil delivery records.

With the annual energy consumption data provided by these records, an estimate may be made of the maximum thermal power requirements. This estimate normally will require an estimated energy conversion efficiency and estimated effective annual load factor, often taken as 2,000 hours in Minnesota. The thermal load requirement for a building may be estimated as the annual fuel input times the energy conversion efficiency times the ratio of 2,000 divided by the number of hours in one year.

The accuracy of this method depends on an estimate or knowledge of the heat source conversion efficiencies, accurate information on fuel consumption, and the assumption that the building will not be modified or reconfigured in a way that would affect future fuel consumption rates.

The second approach is the analysis of the building envelope. Information on building size, construction, windows and use are combined to calculate peak thermal power requirements. This method normally requires engineering expertise. The building may be analyzed based on its expected configuration rather than its present configuration.

In analyzing heat load, it is wise to survey an area larger than that expected to become the initial service area. The FEASIBILITY SCREENING phase may appropriately include the investigation of different service areas and different sections of the community.

Nonheating or process loads must be treated individually for two reasons. First, it is impossible to generalize the energy consumption needs of industrial and process loads. The best approach for estimating these loads is to contact the plant or process owner/operator. If the present load is known in pounds of steam per hour, it may be converted to kilowatts by dividing the pounds per hour by 3.4.

The second reason for individual estimation is that some industrial and process loads will not be suitable for conversion to district heating. It is best to defer consideration of industrial and process load suitability until the next phase. Any industrial or process load identified during this phase should be assumed to be a potential load contingent upon this further analysis.

3.3.4 Balancing

With information on existing heat sources and heat loads, it is possible to make a first attempt at balancing the loads with the sources. The following practical considerations can serve to reduce the number of possible service areas and source combinations to a manageable number. Basic rules to follow are the following:

1. Do not consider new sources if existing sources are available. A first estimate on the size of the service area may be that which can be appropriately serviced by the existing sources.

2. A new heating source may be constructed to serve any size load desired. Economies of scale generally favor larger units and larger loads. If a new heat source is required it will not limit the service area.

3. Consider areas with the highest heat load density first followed by surrounding areas. Areas closest to the source and transmission lines may also be considered as prime candidates, as the distance from the heat source and the routing are important.

3.3.5 Distribution System

When a rough idea of the service areas is known, estimation of piping costs may begin. A reasonable approach is to consider several alternatives ranging from large to small within the limits of the service area chosen.

FIRST ESTIMATE

1. Draw the smallest diameter circle that will encompass all of the proposed loads - measure its diameter in miles.

2. Find the sum of the loads to be served in MW.

3. Add up the number of customers.

4. Measure the distance from the heat source site to the center of the circle drawn in (1).

Use these values as follows:

ADD:	(Diameter, in miles)^2	X	100,000	
+	(Load, in MW)	X	180,000	
+	(# of Customers)	X	2,000	
+	(Distance to Source, in miles)	X	700,000	X Load/50

Cost of Piping =

Different configurations will result in different costs even for the same total load. Ideally, a system should have the lowest dollars per load. The nature of the load also will affect this result. Even when the dollars per load is increased by expanding the circle to include a process customer, the fact that this is a nonheating load may make it worthwhile. Such exceptions should be considered individually after the basic costs are ascertained.

Some fundamentals should be clear: First, it is important for all involved to understand the nature of district heat. Unlike other projects (e.g. a new shopping center) it has fluid boundaries. Similar to the beginning of local electrical service, or water and sewer, there is no clear cut end to the project. This can be unsettling but is in fact one of the positive features of district heat. Boundaries are merely assumptions required for the purpose of analyzing economics and finances. They do not necessarily relate to what is actually built -- and do not limit future growth. It is normal that the minimum initial viable system will not encompass an entire community. Prospective customers outside the area chosen for analysis should be apprised of this fact lest they become concerned about being left out of consideration.

3.3.6 Building Heating System Conversions

Numerous studies of technology and costs of converting buildings to hot water district heat have been far from conclusive. Estimated costs have ranged from $50 to $500 per kilowatt. These costs will vary with the types and condition of the existing building systems. Nevertheless, it is reasonable in this phase to estimate conversion costs on a overall basis of $150 per kilowatt.

3.3.7 Economic Analysis

Taking the sum of the estimated costs for heat sources, distribution systems, and building heating system conversion, the estimated cost of the proposed system can be compared with others that have been studied in greater detail. Past studies in Minnesota have indicated a range for total district heating costs of from $300 to $500 per kilowatt. If the proposed system's estimate is near or above the 500 dollars per kilowatt, it may be expected that the system under investigation is of relatively low attractiveness.

It should not be inferred, however, that a cost greater than $500 per KW rules out feasibility. Specific circumstances in a community, such as extremely low fuel costs for the district heating source and/or extremely high fuel costs (Canadian gas or fuel oil) for the conventional heating alternative may make even this system more cost-effective.

On the other hand, a value for the proposed system near the 300 dollars per kilowatt should be considered in evidence of relative attractiveness. Unless there are unusual circumstances, such as the existence of very high fuel costs for the heating source or very low competitive fuel costs, the system should be considered relatively attractive. Any cost between $300 and $500 per kilowatt is justification.

Local conditions may be used to bias the results at this point, however. If the community is presently dependent on fuel oil or Canadian natural gas for the bulk of the heating needs and is apparently going to remain on such sources, then costs near the high end may still be attractive. If the community uses primarily relatively low cost fuels and that use pattern is not expected to change in the future, then costs near the high end may indicate that further work is not justified. Systems presently in operation and being developed in Minnesota are generally near the lower end of this range.

3.3.8 Marketing

The feasibility of a district heating system depends upon attracting major heat users to the system. Therefore, the potential cost benefits to major users should be investigated in the feasibility screening phase.

The primary emphasis of this investigation should be upon the potential cost benefit to users. Other factors not related to energy costs, however, may affect a user's decision and will need to be investigated. Factors which should be considered where appropriate include:

1. Comparing district heating costs with existing heating systems or potential alternative sources on a short run and long term basis.

2. Estimating the cost of convertng the user's heating system to use heat supplied by the district heating system.

3. The buildings owners' long-term plans for the building or business enterprise.

4. The buildings owners' willingness or ability to finance the investment required to convert to district heat.

5. Determining whether the major users are interested only in short-run cost benefits or are willing to plan on a long-range basis.

6. Determining who will make the decision regarding the use of district heat and how the decision will be made.

7. Determining the users' current level of interest in the possibility of district heating and their willingness to assist in the further investigation of the potential benefits.

The objective of FEASIBILITY SCREENING is to determine the reasonable likelihood of district heating providing a cost benefit to the users and their willingness to seriously consider district heating as an option for meeting their energy needs.

The general community attitude towards district heating should be assessed during this phase. If district heating may be feasible, information regarding district heating should be disseminated to the community and potential users by means of public meetings and local media.

3.3.9 Ownership and Operational Control Options

During the FEASIBILITY SCREENING phase, proponents should take a closer look at who could own or operate the system. A determination regarding ownership and control can be made if there is a logical choice such as an existing system owner or utility, who is willing to accept the responsibility and who is acceptable to potential users.

Existing entities to consider as possible owners include: the public or private electrical utility serving the community, the municipality, the owner of an existing district heating system, major heat and energy users, and potential sources of heat whether from existing boilers, waste heat from industrial processing, or sources of fuel such as burnable wastes.

The primary emphasis during this phase, however, is to determine which alternatives are realistically possible. This involves primarily determining which, if any, existing entities would be interested in accepting the responsibility. Since new public or private organizational structures can always be created to own or operationally control the system, options will be available for the ownership and control of a system if it is financially feasible.

It should be emphasized that ownership and control can change during development. Another choice can be made as plans progress. (For further information, see Section 6.0).

3.3.10 System Funding

At this time, proponents should identify all possible funding sources for development and construction. Several sources probably will be necessary.

During this review, you may want to identify sources that would be preferable if reasonable terms could be arranged. You should also identify and list those that are not available.

Although this review should identify funding for the entire development and construction process, emphasis should be on financing the planning and design phases. Funds may be available from state planning grants, but most likely should be raised locally by the community, the municipal or private utility or other private sources. (Donated staff time and technical assistance from these and other groups can reduce financial need).

Funding for the later development stages may come from state loan funds or short-term borrowing. These funds, however, are only available if the project is certain.

Another financial area that should be considered at this time is conversion loan assistance. Many building owners may have to convert their existing systems to participate in district heating. Since this can be costly and the burden is assumed by the owner, you may want to arrange low cost, long term financing for conversions. This may make the project more attractive to those potential customers.

Although potential funding for system construction is reviewed at this time, a final decision cannot be made. This is determined later in the process when a funding package is completed and agreed upon by funding sources.

The following funding sources should be considered by proponents:

- State loan funds
- General obligations bonds of the city
- Federal loan funds, if available, through HUD, EDA, or Farmers Home Administration
- Revenue bond financing. These may be pure revenue bonds or backed up or guaranteed by the general obligation of the city; tax increment revenues; special assessments; revenues of other utility operations; user contracts or commitments; other independent sources of revenue; or other types of insurance or guarantees acceptable to revenue bond purchasers
- Private loan funds
- Equity investment either for a system to be privately owned and operated or to be leased to the City or other public or quasi public agency or corporation

For further information about funding, see Section 7.0.

3.3.11 Environmental Analysis

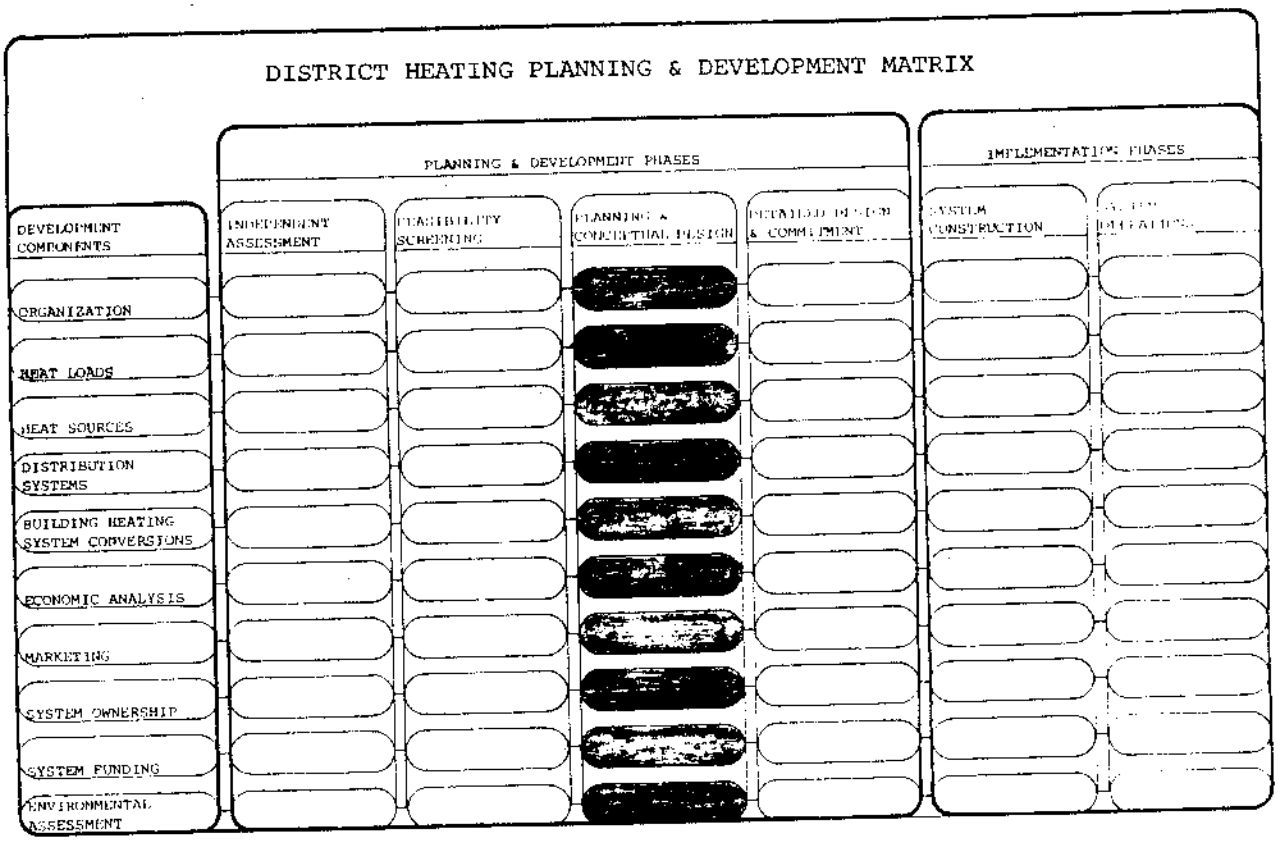
The only direct environmental impact of converting to district heating is a possible change in air quality because of the changing fuel mix used for heating.

With most heat today provided by natural gas, propane, electricity and fuel oil, one benefit of district heating is the capacity to use all of these fuels plus coal, biomass, and others. The efficiency of district heating will mean a reduction in overall fuel use, thereby changing types of emissions.

One conversion deserves special consideration. Some communities with primarily natural gas heating may convert to a coal-fired district heating system. This may increase emissions of some environmentally objectional products. Recent results in St. Paul indicate that even within an environmental nonattainment area, regulatory authorities have not objected to this increase. Instead, they see the benefits of controlling emissions from a single source and dispersing them to higher altitudes. Nevertheless, communities, especially those within nonattainment areas, should consider this problem.

There are many environmental advantages to district heating, stemming from reduced fuel use and reduced rejected heat. In addition, there are no insurmountable environmental roadblocks to district heating conversion. Proponents, at this time, can assume that the project will be environmentally acceptable.

4.0 PLANNING AND CONCEPTUAL DESIGN



Section 4.0 describes the detailed project planning and development process. It describes the important considerations for each planning component and how a community acquires required engineering, economic and financial expertise.

4.1 What is Planning and Conceptual Design?

PLANNING AND CONCEPTUAL DESIGN is an evaluation of all the components of the district heating development project including the development of a conceptual design.

The PLANNING AND CONCEPTUAL DESIGN phase should provide your community with sufficient basis to proceed either to completion of detailed planning and design of the project or to terminate the project.

The results of work in this phase should include:

- A detailed supportable cost estimate of all aspects of the project
- A preliminary detailed economic analysis of the project
- A determination of system ownership
- Sources of funding for the next development phase, DETAILED DESIGN AND USER COMMITMENT
- Identification of the principal funding sources and their requirements for system construction and startup
- A preliminary market analysis
- Conceptual designs for each of the system's components (heat source development, distribution network, and building conversions)

This phase requires professional expertise. Sufficient technical, financial, and systems information is necessary for a detailed design.

Proponents beginning this phase should be seriously committed to a district heating project. Planning and designing is expensive and resources should not be wasted in a project that is unlikely to be feasible.

Although a commitment to proceed is necessary, proponents also should realize that project termination is still an option at this time. Problems can develop during this phase that may warrant project cancellation.

4.2 Planning Methodology

At this stage in project development, preliminary planning is underway and the initial designs for the heat source(s) construction or modification, the distribution system, and general building conversion considerations are being prepared. Both decisions and assumptions are being made on individual projects - based on the unique circumstances and conditions of the community - that desirability will take advantage

of the particular opportunities for district heating that are present.

These local influences establish planning direction for the project. The resulting task and information requirements are quite different from project to project. Factors that are more important for one particular community will have a strong influence on that community's planning process. No single planning methodology description can encompass the diversity of tasks and planning steps that would be encountered in a number of different communities.

Individual communities, therefore, will be required to develop with assistance from their professional consultants and local expertise - their own planning procedures, tailored to their needs. The development component discussions that follow generally describe the important considerations and task requirements and provide some general guidance.

4.3 Development Components

The following sections describe the important considerations and task requirements for each development component during the PLANNING AND CONCEPTUAL DESIGN phase. The content of these sections is presented in a general manner in recognition of the wide array of individual local situations it represents.

4.3.1 Organization

The ideal form of Project Administration for this phase is a project manager available to work with consultants. The position requires:

- Familiarity with district heating processes and technology (or ability to develop that knowledge)
- Sufficient technical expertise to continue through the construction phase
- Familiarity with community resources
- Confidence and support from the community

Generally, a local manager will be more effective than someone from outside the community. Technical understanding of district heating (not necessarily engineering expertise) is a more important prerequisite for this position than administrative experience.

The goals and objectives of the conceptual design process must be clearly understood by all involved at the outset of the project. If this is not accomplished, there is a strong tendency for end result of such a project to be simply a justification for further study.

Two important minimum goals of PLANNING AND CONCEPTUAL DESIGN are:

- A detailed cost estimate must be developed. If properly done, this estimate should be acceptable to most community factions and potential funding sources. A cost estimate that is guaranteed, however, is unrealistic. Reputable consultants will not provide such a guarantee.

- The information generated for this phase must be sufficient to make a decision to proceed with or to terminate the project. A deadline should be set for this decision to avoid project delays.

A schedule for this phase should be prepared in conjunction with the selected consultant. The following factors should be considered:

- Excessively long time spans will usually result in expensive work, over-attention to detail and a tendency to bring in irrelevant or secondary factors. Proponents may lose interest and momentum and become oblivious to outside events such as financial and energy questions. The conceptual design may become out-dated before it is completed.

- Arbitrary or unrealistically short schedules also may result in expensive studies. Focusing on schedules rather than the actual project goals and objectives may result in work that is technically complete, but lacking the details to make it supportable in the funding community.

Schedules are often difficult to meet. It is realistic to plan for delays and be prepared for some flexibility in the timing of critical events.

The timing and scheduling of this phase should be prepared with the goals and objectives in mind. This phase is a decision-making phase. Scheduling this phase requires that sufficient time be allocated to carefully study the questions and allow time for making proper decisions.

- Flexibility in the schedule is important. Some delays should be anticipated. Latitude in the timing of critical events should also be planned.

- The schedule should be developed to follow project goals. Since this phase requires decisions, sufficient evaluation time should be allowed for making those decisions.

The conceptual design of a district heating system is a technical procedure requiring an engineering consultant. A community may simply issue a formal request for proposals (RFP) or simply choose a firm. The following factors should be considered:

- Experience is important and should be checked carefully. Few U.S. firms have any direct experience in hot water district heating.

- An engineering firm with good fundamental capabilities combined with creativity and a willingness to learn may be acceptable.

- The cost of engineering consulting services is of minor concern in comparison with the range and size of construction costs. The construction costs of workable systems have varied by factors of two or more with differing design experience levels.

- The best firms often are very busy and may not respond to your request. Do some groundwork and try to find candidates instead of waiting for them to find you.

- In dealing with large firms, it is important to determine which individuals will actually be responsible for your work.

4.3.2 System Ownership Selection

The selection of ownership and operational control options should be made early in the planning and conceptual design phase of the district heating development process. Ideally, the proposed owners and managers of the system assume the primary responsibility for the planning and conceptual design of the system. It is, however, possible for the planning and conceptual design steps to proceed under the sponsorship of the ad hoc committee or the city with the intention of preparing a development "package" to present to potential owners. (See Section 6.0 for a detailed explanation of System Ownership and Operational Control).

Steps in the selection procedure include the following:

1. Determine which existing public or private entities could be willing to assume the responsibility of ownership or management control.

2. Determine whether municipal ownership or operational control, either directly or through a public utilities commission or other public agency, would be possible. This involves the city's willingness to accept the responsibility, its experience in managing and operating utility systems, the preferences of potential users, and the general attitude of the community as to whether this is an appropriate activity for the city.

3. Determine whether the financial feasibility of the proposed project and the potential return on investment are sufficiently strong to attract some interest in the project by private investors.

4. If ownership or operational control by the municipality, private utility, or private investors are not likely options, it probably will be necessary to form a non-profit corporation or quasi-public agency specifically for the purpose of developing, owning, and operating the system. A user cooperative may be an

appropriate option. This could, however, present organizational difficulties as the system is developed and expanded before "members" are determined.

5. If a non-profit corporation or quasi-public agency is established to develop and operate the district heating system, decisions must be made regarding the organizational structure and how the "directors" are to be selected or replaced. Normally the "directors" would include representatives of the potential users, affected units of government, and the community.

4.3.3 Funding Strategies

All funding options available to the community should be thoroughly investigated during PLANNING AND CONCEPTUAL DESIGN. Each funding option will have differing conditions, requirements, limits, and terms which might vary depending upon the community involved, the size of the system, and its apparent feasibility. Each potential funding source should be investigated to determine:

- If funds can be obtained from that source to assist in financing a district heating system
- The amount of available funding and when it is available
- Conditions, limits, and requirements of obtaining the funding as they may affect the system's size and ownership options and the type of repayment guarantees which are required or acceptable
- Criteria used by the funding source to determine financial feasibility of the system
- The information, analysis, and documentation required by the funding source and the procedures to be followed for obtaining the funding
- Likely terms, conditions, and interest rates

The best source of information about the requirements and terms of potential funding is the funding source. This is straightforward in terms of state loan funds, potential federal loan programs, or other identifiable single sources of funds.

In the case of bond funding or equity investment funding, however, the source of the funds, potential bond holders or equity investors, cannot be determined or contacted. If general obligation bonds, revenue bonds, or equity investment certificates are to be sold to obtain necessary financing, it is necessary to work with bond consultants, bond counsels and financial consultants to determine the legal requirements and market considerations involved in those types of financing. This is particularly true in the investigation of possible revenue bond financing, since the amount of actual or perceived risk will normally

necessitate provisions for guaranteeing repayment or spreading the risk. The investigation of revenue bond financing, therefore, will involve further research into the availability and acceptability of potential methods of guaranteeing repayment.

There are a number of alternatives which may be available to guarantee the repayment or minimize the risk involved in revenue bond or private investment financing. These all involve the assumption of all or part of the risk of repayment if the district heating system revenues are insufficient, by other entities or sources of funds. Potential alternatives include:

- General obligation of the city which, in effect, would be an assumption of the risk by all persons paying taxes to the city. The city could minimize this risk to a certain extent by its control over rates and its power to encourage or discourage alternative heating systems.

- Tax increment finance revenues could be pledged if the system were located in an existing or proposed tax increment financing district which presently or in the future is likely to generate sufficient revenues to provide adequate security.

- A special assessment district could be created to include properties benefited by the proposed system. Provisions could be made to levy special assessments sufficient to cover any shortfalls in revenues necessary for bond repayments.

- Revenues of other utility operations could be pledged for repayment of district heating bonds.

- The repayment of the bonds or loans could be guaranteed by user contracts or commitments to pay their appropriate share of the system cost over the financing.

- The repayment could also be guaranteed by any other independent sources of revenue which may be available to the owners or the community in general.

If revenue bond financing is contemplated, each of these methods of guaranteeing all or part of the repayment should be investigated to determine the amount of risk which is likely to be involved, the willingness of the entity or entities to assume the risk, and the likely acceptability of the guarantee to potential bond holders.

During the PLANNING AND CONCEPTUAL DESIGN phase the conditions, limitations and requirements of the alternative funding options must be coordinated with other planning and design decisions. The requirements of funding options may determine the most appropriate option for ownership or operational control.

The project size may be limited by the amount of available funds. Therefore, the system design may be affected by the need to maximize the ratio of projected revenues to required investment or other requirements of funding sources or entities assuming the risk.

Consideration must also be given to funding of the DETAILED DESIGN AND USER COMMITMENT phase of the process. Normally the cost of DETAILED DESIGN AND COMMITMENT phase will be folded into the construction costs and paid over time by user revenues. State loan funds and/or other local sources of funds will probably be required to finance this phase of the planning process.

The primary risk involved in this funding is whether or not the system is built. This risk will be minimized if the planning and conceptual design phase clearly indicates that the proposed system is feasible and that all parties necessary to the establishment of the system are willing to participate.

Consideration should also be given to providing assistance in obtaining financing for individual users to convert their buildings to enable them to utilize district heat. If obtaining financing on reasonable terms appears to be a significant obstacle to the marketing of district heating, consideration can be given to providing revenue bond financing for conversion or providing guarantees of private conversion loans.

For additional information about funding options, see Section 7.0.

4.3.4 Conceptual Design

Select and negotiate commitments on heat sources and cost estimates. Investigate permits and other equirements. Prepare conceptual design and cost estimates.

Layout alternative routings. Make preliminary sizing of pipe. Prepare preliminary cost estimates. Identify potential installation problem areas.

Estimate/refine building by building heat load. Estimate cost and generate design. Refine proposed service areas.

4.3.5 Preliminary Market Analysis

The preliminary market analysis consists of determining which potential customers are interested in a district heating system, whether potential major customers (heat loads) needed for system feasibility are willing and able to use district heat, and whether smaller users are, in general, interested in the system.

A major task in this phase is contacting individual potential customers to determine under what conditions they would purchase this heat from the district heating systems.

Steps to be taken as part of this market analysis and marketing program include:

- Initiating a plan to provide the public and potential customers with information about the benefits, costs, and risks of a district heating system and the specific conceptual designs being considered.
- Identify and contact the decision-makers (owners, managers, corporate presidents, board of directors, etc.) for major potential users to determine whether they will purchase heat from the district heating system.
- Conduct a preliminary market survey of all potential customers in areas proposed to be served to provide information regarding the system and its benefits and to determine their interest in joining the system.
- Prepare a marketing plan for securing commitments from potential customers.
- Prepare detailed cost-benefit analyses for potential major users and illustrative analyses for various types of smaller users.

Based on this information, estimates can be made of which major users and what percentage of smaller users are likely to purchase heat from the system. The analysis also will determine what activities or conditions will be needed to obtain required commitments and develop a plan which will meet those conditions.

4.3.6 Preliminary Economic Analysis

An economic analysis should be made of the likely cost benefits of proposed conceptual designs of a district heating system. As more detailed cost estimates are developed for alternative system configurations and the projected cost benefits to individual major users and various categories of smaller users can be determined.

The goal of preliminary economic analysis in this phase of development is to demonstrate the economic feasibility for both prospective customers and funding sources of the proposed district heating system by comparing the unit cost of district heat, based on detailed planning and conceptual designs of the system, with the projected unit cost of heat energy with the continued use of existing sources.

Individual end user cost-benefit analysis must also show favorable results based upon the same system economic analysis plus consideration of conversion costs, projected heat loads, and projected costs for their present heating system and fuel sources for a specific building or buildings.

4.3.7 Building Heating System Conversion Studies

Inventory all buildings:

1. System type
2. Fuel type
3. Load estimates

Estimate conversion costs based on system type for local community. Analyze industrial loads/conversion costs in detail.

4.3.8 Environmental Impact Assessment

Prepare and submit to the Environmental Quality Board the completed Environmental Assessment Worksheet. Sample forms are included in the Appendices.

4.3.9 Design And Construction Choices

Capital projects today are being constructed with the traditional design and bid process or the design/build approach. With municipal ownership the design bid approach is often the only legally acceptable approach. Design/build may offer significant advantages, however, such as the opportunity to obtain relatively firm project costs for funding sources with a minimum initial investment. For a project that has reached this stage, the design/build approach should be investigated in conjunction with the professional consultants and the municipal legal staff.

4.4 Implementation Strategies - Examples

Minnesota communities may be classified into three categories that will affect how implementation of a district heating system is approached.

4.4.1 Municipal Community With An Electric Utility Supplying Municipal Steam

Communities in this situation are most fortunate because of the high level of local expertise. Municipal utilities are experienced in producing and distributing thermal energy. It is important that a municipal utility be a fundamental part of any district heating development effort.

Experienced utility personnel can best judge which implementation strategy to follow as long as they update themselves on district heating technology and funding. They can also follow through on implementation, even if the new district heating system takes a different form.

A preferred implementation strategy is not necessary here because of the available expertise. However, the project should start with a review of the existing district heating system, its condition and market, plus a look at competitive thermal energy suppliers, if any exist in the community.

4.4.2 Community With A Municipal Electric Utility Without Generation Capability

In this situation, the municipal utility distributes electricity purchased from outside suppliers. Since they do not generate power, these utilities may have limited technical and financial expertise in the areas needed for district heating implementation. While their representatives should be involved in implementation programs, they cannot be expected to have the same expertise of generating utilities and may on occasion see the proposed district heating system as a threat to their status in the community. While each community situation differs, it is usually appropriate to conduct the initial stages of investigation independent of the distribution utility. It will usually become apparent if the municipal utility will be supportive of the furtherence of the project. It should be obvious that their participation and support are desirable.

4.4.3 Community With No Municipal Electrical Utility

A community without a municipal utility has one major consideration. Along with the developing a district heating system, the community faces the question of starting a municipal utility. While this is not impossible, it may be both difficult and controversial in many communities. Communities may want to contact the Minnesota Municipal Utilities Association (MMUA) for assistance.

These communities are free to investigate non-municipally-owned options for district heating development. This can be more difficult, but it also offers the community a choice of broader options.

4.4.4 Problems and Pitfalls

There are many ways in which a project can go awry. While it is not possible to identify them all, common ones include:

- Fluid Service Area There is a tendency during the planning stages to continually modify the proposed service area usually making the system even larger. The result often is an expensive study, a service area that goes beyond the economic area chosen by consultants, and a project too large for initiation by the financial resources to the community.

It is quite easy to make a project completely unworkable through enthusiasm and well-meaning expansion. Prospective customers should understand that the initial service area must be fixed to allow for analysis, that inclusion or exclusion in the study phase is not at all binding on either the early or later development phases or future growth.

- The Wrong Consultants Experience shows that an otherwise knowledgeable consultant, if lacking in direct experience and/or creativity, will usually develop needlessly expensive concepts. It is not necessary to go outside of the U.S. for consulting services American consultants have been acquiring modern European district heating technology knowledge and experience.

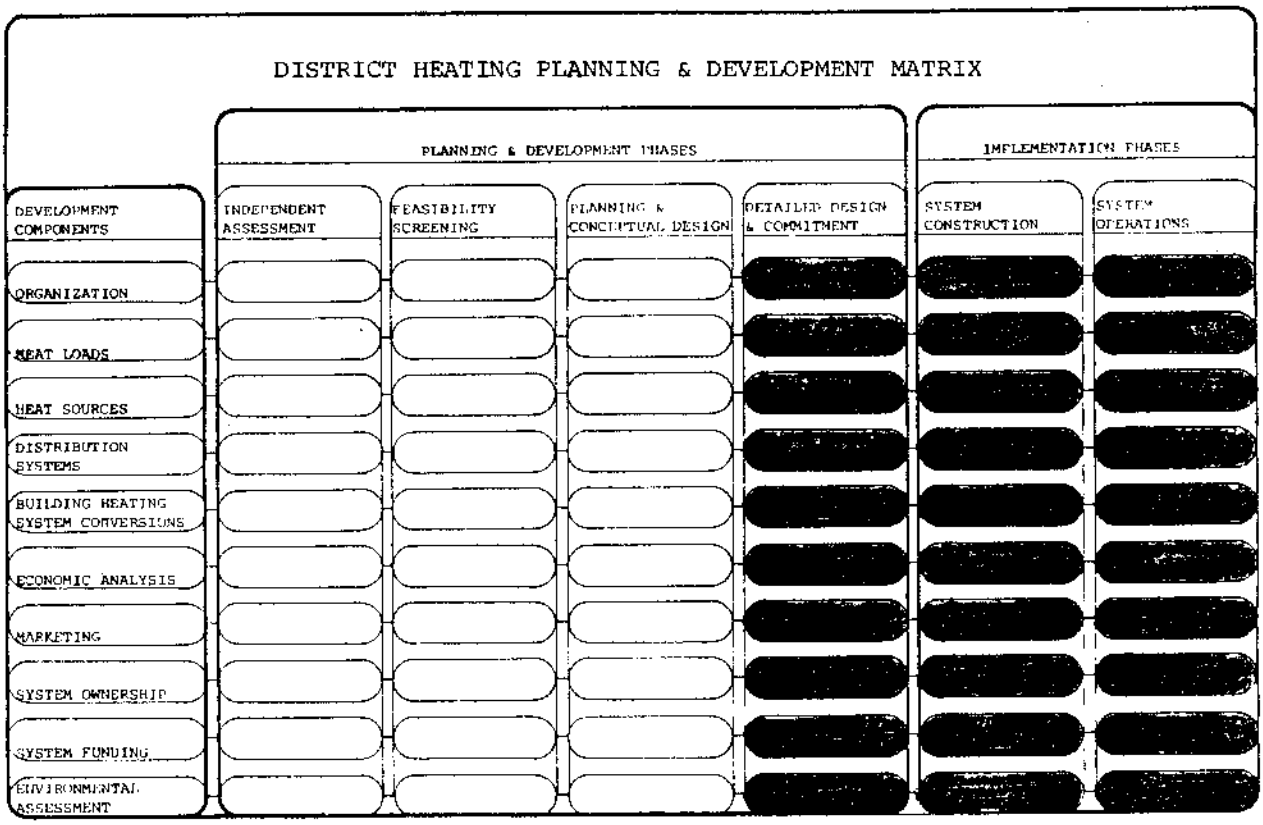
  In any event, it is important to realize that the project design is essentially an engineering job and the use of non-engineering consultants in any technical aspects of the work has not been satisfactory.

- Risk Avoidance There is a natural tendency for individuals and institutions to attempt to avoid financial risk. Unfortunately, this often means transfering risks to others.

  An economically successful district heating system is not yet considered a sure thing by the financial community. Someone must take this risk and there may be a temptation to transfer it to the least vocal or least immediate group. It appears the best way to solve this difficulty is to appropriately share the risk amongst the various participants.

- Lack of Communication in the Community District heating development is difficult if any significant portion of the community feels left out of the decision-making process, or if established power blocs perceive threats. If those initiating development are obviously working towards personal gain, the balance of the community may work to stop the project regardless of its merits. The importance of peripheral issues should be recognized.

5.0 DESIGN / CONSTRUCTION / OPERATION



Section 5.0 DESIGN / CONSTRUCTION / OPERATION briefly describes the planning and development process in the final planning phase - Detailed Design and User Commitment - and two following implementation phases of district heating development - System Construction and System Operations.

5.1 DETAILED DESIGN AND USER COMMITMENT

DETAILED DESIGN AND USER COMMITMENT phase completes system planning. With the preparation of construction plans and specifications, final economic analysis, final market analysis and with the securing of acceptable construction bids, funding sources, and customer base, a community may begin construction.

Detailed design of a district heating system may be approached in much the same manner as design of other capital improvements for the community, such as water and sewer systems, and schools. Since modern district heating technology is relatively new to the United States, extra care must be taken in the choosing of consultants. The community should be assured that the chosen designer has sufficient experience in this particular area. Also in this regard, it is important to schedule sufficient time for the design process to allow for proper technical input and careful review before the bidding process.

Additional information about system funding for this phase is found in Section 7.0.

5.2 SYSTEM CONSTRUCTION

The SYSTEM CONSTRUCTION phase consists of the installation, renovation, and/or conversion of the physical components of the system (heat sources), distribution network, and end user equipment and systems.

Like design, construction of a district heating system is similar to construction of other capital improvements for the community. However, construction skills required for installing district heating piping are somewhat unusual. Again, a contractor should be properly qualified before the bidding process to assure that construction errors do not occur.

System construction should be scheduled during warm weather months, normally between April and November. Sufficient time should also be allowed for start-up and trouble-shooting as well as service connections before actual heating is to be expected from the system. It should be noted that typical delays in construction may become most serious if customers are left without heat into the winter. It is also wise to plan for significant residence services from the engineer on the job.

5.3 SYSTEM OPERATIONS

The final phase, SYSTEM OPERATIONS, consists of startup and operation of the district heating system. It represents successful completion of the district heating development process.

The actual operation of a hot water district heating system, especially small ones, is relatively simple and usually highly automated. However, there is no experience at the present time in this country with such operations. It is important for the community to require sufficient training and start-up services from the system designer or builder so that the district heating operations staff can deal with both expected and unexpected operational situations.

6.0 OWNERSHIP AND OPERATIONAL CONTROL OPTIONS

OWNERSHIP OPTIONS	SYSTEM COMPONENTS: Heat Sources	Distribution System	Building Heating System Conversion Equipment
Municipal			
Municipal Utilities Commission			
Special Public Agency			
Privately-Owned Public Utility			
User Cooperative			
Private Profit Motivated Non-Utility Company			
Non-Profit Corporations			

This section explains various ownership options for district heating systems. It describes the primary criteria for selecting the most suitable options and outlines additional considerations regarding ownership options for the separate system components. (This information is referred to in previous chapters).

6.1 Ownership and Operational Control

There are a number of ownership options for all or portions of a district heating system. Each community will need to determine which options are realistic in the community and select the most viable option in terms of obtaining financing, assuming risk, and future operating efficiency.

Various parts of a district heating system can, and often may, be owned by different entities. For example, the central heat source may be owned by a public utility; the distribution lines may be owned by the city; and the individual space heaters may be owned by final consumers.

Furthermore, the operation and control of the system may be separate from "ownership" through lease arrangements. A system could also be developed by one group with the idea that ownership or operation would be transferred in the future by lease or sale to a permanent owner or operating agency.

The internal distribution system within the buildings of the various users would normally be owned and maintained by the users. However, some equipment such as meters and heat exchangers, although located on the users premises, may be owned, operated, and maintained as part of the distribution system. This is similar to a water utility.

Ownership options include:

- Municipal Ownership - This may be a department of the municipality or a public agency owned and controlled by the City such as a Public Utilities Commission (Minnesota examples of such district heating systems include Hibbing, Rochester, Virginia, Willmar, and most other existing steam systems).

- Quasi-public Agency - A separate independent agency with governing board appointed in whole or in part by governmental units.

- Non-profit Corporation - A non-profit corporation could be established to own or operate the system. The governing board could be self-perpetuating, consist of representatives of various segments of the community, or, be elected by "members". (Example: St. Paul District Heating Development Corporation).

- Private Utility - The system could be owned or operated by the private electrical or natural gas utility serving the community or which has a nearby source of heat. (Example: Minnegasco Central Heating Company in Minneapolis).

- Private For-profit Corporation - Established as an independent profit-making business which may involve a franchise from the municipality. (Example: Minnegasco Central Heating Company in Minneapolis).

- Cooperative - The system could be owned and operated by a user cooperative. (Example: Duluth).

- Private Equity Investment - The system would be owned by private equity investors although leased to and operated by a private company, utility, or public agency. (Example: Minnegasco Central Heating Company in Minneapolis).

Ownership options depend upon the willingness of existing entities or potential new ones to assume the risk of ownership or to accept the responsibility of operational control. Other important factors are: the availability of financing at reasonable rates and terms, exceptional of an ownership choice by potential users, control over development of the system, and, long term control over the operation, maintenance, and rates of the system.

6.2 Selection Criteria

The most appropriate ownership option for each system will vary in each community. Factors which should be considered include:

1. Willingness to accept the responsibility and assume the risk of developing or owning the system. Private utilities, cities, Municipal Utilities Commissions, or other existing entities may decide that they are unwilling to accept ownership. There may be no private investors interested in the project either as equity investors or for the business itself. Potential users may not be interested in forming a cooperative.

   If these groups are unwilling to accept ownership or operating control, it would be necessary to create a new agency or corporation to develop, own, and operate the system.

2. The second criterion involves the availability, types, and terms of financing. These will vary depending upon who owns, develops, and operates the system. Revenue bond financing would normally be available under all ownership alternatives but the rates and terms may vary. Government grants, state district heating loans, general obligation bonds, and private financing may, however, be legally unavailable or not realistically available under some ownership options. Since the financial package may not be completed until late in the planning process, the ownership option may not be resolved until then. not be resolved until then.

3. The third criterion involves the acceptance by to the potential users. The feasibility of a district heating system depends upon attracting potential users. If needed major users or numerous small possible users have preferences, selecting other options could significantly affect the marketing of the system.

4. The fourth criterion involves the long term management and control over the system including rate setting. Management and control of a system can be separated from ownership by means of contracts or lease arrangements. Rate setting may also be separated from ownership by means of contract or franchise terms. The owner or operator, however, will have a substantial impact upon the future development and operations of the system. Factors to be considered include: Experience in operating business enterprises, responsiveness to the needs of users or potential users, likely amount of interest in expanding the system, and responsiveness to community goals and objectives.

6.3 System Components

Various components of a district heating system can be owned or generated by separate entities. Major sections of the district heating system are the primary and backup heat sources, the distribution system, plus the equipment and internal distribution system within the user's building for actual heating. Some options available for ownership or operational control of various system components will be discussed in this section.

6.3.1 Heat Sources

6.3.1.1 Primary Heat Sources Existing heat sources are likely to be electrical generating facilities which provide heat through co-generation or from separate boilers. Each benefits the generating plant's fuel handling capability and fuel supply contracts.

Private utilities are often willing to provide heat to an independently owned and operated distribution system. However, they have shown minimal interest in owning and operating a distribution system. This lack of interest is due primarily to the difficulty of generating an adequate return in the short run on the high initial investment and fears of how electric rate regulators will allocate district heating costs and investments.

If the municipal utility is the potential primary heat source, it is also the preferred selection for owning and operating the distribution system. Municipal utilities need not be concerned with return on investment or how outside agencies may allocate cost for rate purposes. Although municipals must be concerned about debt service obligations, the revenue needs to meet these obligations can be delayed or minimized during the early years of the project (debt financing of early years' interest payments and delayed or graduated repayment of principal).

Municipal utilities are often able to obtain better financing terms. They have experience in operating utility systems. If appropriate, they may pledge surplus revenues from the electrical system as a guarantee for district heating revenue bonds.

Other existing potential heat sources such as businesses or institutions with excess energy capacity, or those having waste products which can be utilized as fuel, are unlikely to be interested in new enterprise requiring investment, responsibility, and assuming the risk of owning and operating a district heating system.

If a new heat source is established for the district heating system, it is likely that the heat source and distribution system will be owned and operated as single operation.

6.3.1.2 **Backup Heat Sources** Backup heat sources are essential to most district heating systems to provide continued heat if the primary heat source becomes inoperable. Individual users, such as hospitals, need guaranteed supplies or reasonably available backup sources capable of meeting the needs of the entire system.

Backup systems can include mobile boiler systems or readily available temporary boiler systems. These normally would be owned and operated by "the system".

Another way to provide backup is to maintain existing heating systems of major users for operations if necessary. The existing backup capacity could be purchased and, if necessary, operated by "the system" or ownership could be retained by the existing owner subject to contractural obligations to provide heat in an emergency.

6.3.2 Distribution Systems

The ownership and operation of a district heating distribution system may be entirely separate from that of the heat source. The owner and operator of a distribution system may contract with one or more primary and backup sources to purchase heat which they resell to the users.

There are several options available for owning and operating a distribution system. These include municipal ownership, public agency, quasi-public agency, privately owned public utility, user cooperative, and private, profit or non-profit, companies.

Furthermore, the ownership of a distribution system can be separated from operational control. A private profit or non-profit corporation, a quasi-public agency, a user cooperative, or a group of private investors may be willing to accept the responsibility and assume the risk of ownership but prefer to contract with a private utility, a municipal utility, or private operating company to operate and maintain the system.

6.3.3 User Equipment

In most district heating systems, the user would own and maintain the facilities and equipment on his premises needed use and distribute heat supplied by the system. The "system", however, could own, operate and maintain heat converters, meters and gauges located on the user's premises. The owner of the distribution system could also help finance the costs of converting the internal distribution system to use district heat.

6.4. Ownership Options

There are several options for owning and operating a district heating system or its primary components. This section will review some salient characteristics, plus the possible advantages and disadvantages of various options.

6.4.1 Municipal Ownership

This option involves direct municipal ownership of the district heating system operated as a department of city government. Direct management of the system would depend upon the organizational structure of the municipality. The manager of the district heating system could report either to a public works or public utility's department head, or a city manager, or directly to the mayor or city council.

The city council would be responsible for all policy decisions relating to the ownership or operation of the system. Rates would be set by the council subject to possible contractual obligations to heat suppliers, funding sources, and users.

Funding options available under municipal ownership include state loans, most federal loan programs, general obligation bonds, revenue bonds and, possibly, private equity investment. State loan funds, general obligation bonds, or revenue bonds backed by the general obligation of the city or other municipal revenue sources would be the most likely funding sources under this ownership option.

The primary advantages of a municipally owned system, whether managed directly by the municipality by a utilities commission, or by a municipally-owned corporation, include the ability to obtain financing at advantageous rates and terms and the ability to ensure the system would be established and operated in accordance with community goals and objectives.

State loan funds are available only to municipalities, municipal utilities commissions, or municipal corporations (although it may be possible for them to reloan to other entities). The proceeds of general obligation bonds or revenue bonds backed by the general obligation of the municipality also may be loaned to other non-municipal entities. Many municipalities, however, may be reluctant to use their general

obligation credit to finance a district heating system which the municipality does not own, operate or control.

The interest rates on state loan funds, general obligation bonds, or revenue bonds backed by the general obligation of the municipality will normally be lower than other potential finance sources. Lower financing costs presumably will result in lower user charges. This would tend to enhance the feasibility of the system and provide cost benefits to users.

The primary disadvantages of municipal ownership include potential municipality's reluctance to be involved in a project which only benefits a portion of the community, and the possibility that general community goals and objectives may prevent the system from being operated in the most efficient businesslike manner.

Marginally feasible extensions of district heating systems may be desirable in terms of providing the services to as many persons as possible, but may, in effect, require subsidization by large close-in users.

In summary, municipal ownership is an attractive option if the municipality is willing to accept the responsibility and assume the potential risks of owning and operating the district heating system.

6.4.2 Municipal Ownership - Municipal Utilities Commission

Under this ownership option, a district heating system would be owned, operated and managed by a municipal utilities commission. The directors of a public utility commission may consist of the city council or may, pursuant to statute or home rule charter, be selected in another manner. The community, however, retains control of a public utilities commission through their elected representatives.

The advantages and disadvantages of this option are similar to those of direct municipal operation. Municipal utilities commissions have experience in owning and operating a utilities system. They have a track record for obtaining credit on favorable terms. They have other revenue sources which may be available to assist in handling cash flow problems or which could be used as a guarantee for revenue type bonds.

If a municipality has a utilities commission operating other utilities, the ownership and operation of a district heating system by the commission is an attractive option.

6.4.3 Special Public Agency

A municipality or other governmental body could establish a public or quasi-public agency to own and operate a district heating system. Such agencies could be organized in several ways with varying degrees of direct or indirect control by the municipality or other governmental

body. If a public non-profit corporation were organized pursuant to Minnesota statute 317 where membership is limited to the mayor and governing body of the municipality, such an agency would qualify as a direct recipient of loans or grants from the state pursuant to the Minnesota District Heating Loan Act.

Control of the system under this option would be by the "members" or "board" of the corporation or agency. If the board consisted of the mayor and council, the municipality would retain complete control over the management and operation of the system. Under other alternatives, the municipality would retain only indirect control through the power of appointment and removal of board members.

The rates under this option would be set by the board of the corporation subject to contracts with the users and subject to contract or franchise agreements with the municipality.

A special public agency would have no source of income prior to construction of the system and therefore would depend upon grants or possibly loans for planning the system. Revenue bond financing would be the most likely financial source under this ownership option. The municipality, however, could loan the agency or corporation the proceeds of general obligation bonds or pledge the general obligation of the city in support of revenue bonds.

The primary advantage of organizing a special public agency or corporation compared to direct municipal ownership, is to separate it from operations of municipal government. This may permit operating and expansion decisions to be made on a strict cost/revenue basis without considering other factors which can and often necessarily do affect decisions by govenmental bodies. Such agencies or organizations also may have more freedom of action in terms of contracting for system construction, fuel or heat, staffing, and operating procedures.

The primary disadvantage of a special public agency or corporation is that it may have greater difficulty in obtaining financing unless guaranteed by the municipality or by other means. Such an agency or corporation would have no credit rating, no financial reserves, and no experience owning and operating a utility system.

6.4.4 Privately Owned Public Utility

A district heating system can be owned by a privately owned public utility system. This could include utility cooperatives. The utility would be managed by the board of directors or stockholders of the corporation or by the members of the cooperative. Rates would be set by the utility subject to contractual or franchise requirements of the municipality and subject to contracts with various users.

Under this option, normal funding sources used by the utility, including equity investments, corporate bonds, and private loans, would be available for the district heating system. The municipality also could

loan the utility the proceeds of tax exempt revenue bonds or general obligation bonds issued by the municipality.

The primary disadvantage of a private public utility is that its goal of maximizing profit and minimizing risk may be inconsistent with the community's desire to provide district heating to as large a portion of the community as is economically and financially feasible. Also, large utilities are heavily regulated which greatly restricts their options. They are less likely to get concessions on rates or pollution standards. Although willing to provide heat on an individual basis to very large users, private public utilities presently are exhibiting little or no interest in establishing district heating systems.

The primary advantage of a private public utility is their experience in owning and operating a public utility system. They also have experience in developing, designing, monitoring, and operating utility systems. Joint use of technical, management, and maintenance personnel could result in cost savings.

Furthermore, this ownership option normally would only be considered if the utility owned the proposed primary heat source. Ownership and operation of the distribution system as a unified system would avoid any potential problems which may arise from separate ownership. Ownership and operation of a district heating system by the private utility operating in the community may be an attractive option if the utility itself is interested.

6.4.5 User Cooperative

A district heating system could be owned and operated by a user cooperative such as a townhouse or condominium development. This would permit management and control by the users who would have the greatest direct concern in the efficient and effective operation of the system.

The system would be controlled by the board of directors elected by the users, each of whom would be a member of the cooperative. The board would have the power to set rates subject to any contractual obligations to funding sources, the municipality, or the heat source.

Potential funding sources under this option would be private loans or bonds which, most likely, would need to be guaranteed by the members, the municipality, or by other means. Loans from the municipality of the proceeds of the general obligation or revenue bonds also are a possibility.

A user cooperative would appear to be a good realistic ownership alternative for a fully established operating system. However, the adminstrative problems of organizing a cooperative and making decisions prior to the time when it is clear who the "members" are or will be, however, make this an unattractive option for the planning, construction, or expansion of a new system.

6.4.6 Private Profit-Motivated Company

A district heating system can be developed, owned, and operated by a private profit motivated company in a manner similar to other business enterprises. This could include companies whose primary business would be developing and operating a system, or developers seeking to enhance the attractiveness of new developments, or major users seeking to spread the cost of building or operating their own heating systems.

The owners of the company would control the operation of the system subject to contracts or franchise agreements with the municipality and contracts with users. Rates would be set by the company.

At this time one major disadvantage over shadows its benefits since district heating requires substantial front end investment, there is considerable actual or perceived risk involved. Most private businesses currently consider the potential profit from return on equity investment to be too low to justify the financial risk.

A private company can obtain necessary funding from private sources in the form of equity investments or loans or then the proceeds of revenue bonds or general obligation bonds from the city. Unless the company has substantial assets, some form of repayment guarantees would normally be required.

Private investors in a district heating system would be able to take advantage of various investment credits and depreciation and deductions which would increase the profit potential of such investments. If a number of district heating systems are established and successfully operated, it can be anticipated in the future, that private businesses and investors will exhibit increased interest in district heating investments.

6.4.7 Non-Profit Corporations

A district heating system could be owned and operated by a private non-profit corporation. This system would be controlled by a corporation board of directors who in turn would be selected by the "members." Non-profit corporations have great flexibility in determining membership. If membership is limited to the board of directors, the corporation would be controlled by a self-perpetuating board. The "membership" base, however, could be substantially broader and include representatives of various segments of the community or could include all users or potential users.

Rates would be set by the board of directors subject to any contractual obligations to the municipality, users, or funding sources.

The most likely funding source under this option would be revenue bonds guaranteed in whole or in part by the municipality, users, individual commitments, or other sources of revenue.

One advantage of non-profit corporation ownership is that it is always available even if no other entity is willing to accept the responsibility and assume the risk of ownership. A non-profit corporation also has at least the potential ability to make timely decisions regarding the planning and development of a system.

The primary disadvantage of non-profit corporation ownership is its lack of independent resources and funding sources. Funding sources normally will require loan or bond repayments guarantees by potential users, the municipality, or other revenue sources. Outside entities may be reluctant to guarantee loan or bond repayments if they have little or no control over the planning, development and operation of the district heating system owned or operated by a non-profit corporation.

7.0 SYSTEM FUNDING STRATEGIES

FUNDING SOURCES / DEVELOPMENT PHASES	Independent Assessment	Feasibility Screening	Planning & Conceptual Design	Detailed Design & Commitment	System Construction	System Operations
Federal Grants						
State Planning Grants						
Municipal Contributions						
Business/Community Groups						
Potential Users						
Foundations						
Private Investment						
State Loans						
General Obligation Bonds						
Revenue Bonds						
Private Loans/Equity Investments						

This section summarizes various sources of district heating development funding. It examines in detail the more promising funding options available for each development phase. With this information, communities may begin planning their own funding strategies and defining the detailed requirements of the proposed funding services. (This information is referred to in previous chapters).

7.1 Funding Sources

There are several funding sources which may be available for planning and implementing a district heating system. Appropriate sources will vary considerably from community to community. Potential funding sources available for the various planning phases also will be different. Furthermore, the funding sources for construction will be different than those for the planning process.

The costs of establishing a district heating system should be paid over time by the system users. The detailed design and construction phases normally would be funded with borrowed money repaid with interest from user charges.

Loans are not appropriate for earlier planning phases. Until final commitments are obtained to establish a system, there is no certainty that the system is feasible or will be built. Thus, there may be no source of revenue to repay the loans.

Funding for the earlier planning phases must, therefore, depend upon grants, contributions of staff time or money, private equity risk investment, or loans whose repayment is conditional upon the system being built. Potential sources of planning funds are outlined below.

- Federal grants. Although federal energy grants are unlikely to be available in the future, it may be possible to include district heating planning as part of other types of grants such as HUD community development grants or Urban Development Action Grants.

- State planning grants. The state has $200,000.00 available in fiscal year 1982 for planning grants to municipalities interested in establishing district heating systems. Limited to $20,000 per municipality, these grants would be available during the planning process after the apparent feasibility of the system has been determined.

- Municipal contributions of staff time and funding. The municipality, particularly if it operates an existing district heating system or electrical utility, could invest the required staff time or funds to hire outside assistance to plan a system and determine feasibility.

- Business or community groups. Business or community groups could contribute personal time and funding to assist in planning the system.

- Potential users. Potential users of district heating systems, particularly major energy users, may be interested in contributing time or money to plan a district heating system.

- Foundations. Foundations may be willing to assist in funding district heating planning. This is particularly true of foundations sponsored by major local industries who are interested in local community projects.

- Private investment A private utility, other potential sources of heat, or private investors may internally finance the planning and feasibility determination if they contemplate owning or operating the system. A private utility or other heat source may also contribute time and money to plan a publicly operated distribution system which would purchase their heat.

There are also a number of potential funding sources for the planning and conceptual design phase and also the construction phase:

- State loans. The State of Minnesota has authorized the issuance of up to $50 million in state bonds, the proceeds of which are to be used to make loans to municipalities or municipally-owned agencies for detailed planning and construction of district heating systems. The regulations regarding this program are presently being drafted.

- General obligation bonds. A municipality may issue general obligation bonds, the proceeds of which may be used to construct a municipally owned system or may be loaned to the public, non-profit, or private corporations or agencies which would own or operate the system. General obligation bonds require a commitment of the general taxing authority of the municipality to repay the loans. The interest rate will vary depending upon the bond rating of the municipality and general market conditions for tax exempt bonds.

- Revenue bonds. Tax exempt revenue bonds can also be issued by a municipality. These include pure revenue bonds with repayment coming only from revenues of the system or revenue bonds guaranteed in whole or in part with revenues from other sources. Since district heating systems now are perceived to involve significant risk, pure revenue bonds likely could not be marketed in the general bond market. Private placement within the local community (consortium of financial institutions, private investors, major users) may be possible for smaller projects.

  There are various guarantees which may be available and useful in making revenue bonds marketable or reducing their interest rates. If they are guaranteed by the municipality, the bonds in effect become general obligation bonds.

  Other potential sources of guarantees of all or part of the bonds include: special assessment districts; user commitments to pay a share of the debt service regardless of amount of heat used; tax increment financing revenues; elective utility or existing district heating system revenues; or any other available source

of revenues. Revenue bonds with or without guarantees could be used by public or privately owned district heating systems although they would need to be issued by the municipality.

- Private loans or equity investment. Private loans or equity investment are potential funding sources particularly for a system to be owned and operated by a private utility or profit-making corporation. Interest on private loans would be taxable and, therefore, would have higher interest rates than most tax exempt bonds.

  There may, however, be tax credits and deductions available for equity investment in district heating systems which could make that method of financing more attractive. This is particularly true if market conditions continue to make it increasingly difficult to market long-term bonds at reasonable rates.

  There is a potential problem involved in all tax exempt funding alternatives requiring over ten million dollars in funding. District heating bonds could be classified by the Internal Revenue Service as industrial revenue bonds which, if issued for more than ten million dollars, are not tax exempt. A revenue ruling has been requested regarding the tax exempt status of district heating bonds and a decision is pending.

7.2 Funding Options

This section outlines potential funding options which may be available during various phases of the planning and implementation process. Current projects in the planning stages are aided by substantial grants from the Department of Energy. It is doubtful that similar grants will be available in the foreseeable future. This will increase the likelihood that a significant local contribution and commitment will be necessary during the planning process. The local community, including the municipal government, potential users, and the local business community will need to assume greater responsibility and risk in the implementation of the plans.

The purpose of this work program component is to explore all of these funding options and others which are uncovered as suggested. Factors which will be considered for each option include:

- The total amount of funds potentially available for an individual project or for all Minnesota projects.

- Likely interest rates or required return on investment. Since tax exempt public bond financing or state loans are potentially available for most proposed systems at lower interest rates for the same risk, private financing should be considered only as last resort.

- Amount of risk the sources are likely to deem as being acceptable.

- Likely conditions on the availability of funding relating to such factors as user commitments, loan guarantees, equity requirements, projected gross and net operating revenues, and debt service ratios.

- Information, analysis, and documentation necessary or desirable to obtain funding commitments.

The planning and implementation of a district heating system involves the commitment of considerable time and funds. The system will benefit the users and the community only if it is financially and economically feasible. This increases the importance of the preliminary feasible study and development of a concept design which makes financial sense and can be implemented.

Funds for the "next step" in the planning and implementation process will be difficult to obtain locally or from outside sources unless the financial feasibility and economic benefit of the system can be sufficiently demonstrated in "this step". The following section outlines potential sources of funding for the various phases. Funding is likely to be available from any of these sources only if it can be demonstrated that there is sufficient likelihood of developing a feasible project to justify assuming the risk of funding the next phase.

7.2.1 Independent Assessment

The independent assessment phase of the planning should require little funding. This phase is designed to be conducted by local people at little expense other than some of their time.

7.2.2 Feasibility Screening

This phase will involve a feasibility screening based on existing or potential energy sources, existing and projected costs for alternative fuels for district heating compared to existing heat systems costs, demand/distance ratios, and the costs of converting major users.

This phase normally is funded locally, although State Preliminary Planning Grants may be available for latter portions of this phase.

Potential sources of funding include:

- State energy Preliminary Planning Grants

- Municipal funds

- Community or business groups

- Electric or existing district heating utilities
- Potential users
- Local foundations which have a particular interest in projects benefiting the community

Potential sources of technical assistance include:

- Minnesota Energy Agency
- Municipal, county, or regional commission staff
- League of Minnesota Cities
- Private Utilities
- Community volunteers
- Educational institutions
- Employees of local businesses
- Foundations
- Consultants specializing in the technical, financial, or legal aspects of district heating planning

7.2.3 Planning and Conceptual Design

This phase involves analyzing the feasibility of various alternative design concepts. Factors which need to be analyzed in detail include: capital investment requirements for generating heat, distribution system and common costs, operating cost projections for fuel (less cogeneration set-offs), operations, maintenance, debt service or return on investment requirements, existing and projected costs of existing systems, demand analysis including heating requirements and market acceptance or interest. The purpose of this phase is to develop a concept plan which is financially feasible in terms of customers short-range or long-term costs and in terms of obtaining needed funding.

Funding options which may be available for PLANNING AND CONCEPTUAL DESIGN include:

- Federal or state loans or grants
- Foundation grants
- Municipal funds
- Community or business groups

- Public utilities
- Potential users

The State Energy Agency preliminary planning grants can be of considerable assistance in funding out-of-pocket expense for this phase including the employment of district heating specialists which may be desirable for developing a feasible concept plan.

The local community or potential owners must make a commitment of time, money, and energy to the program. This should involve municipal staff as well as community and business representatives. The local commitment is necessary to assist in compiling needed local data and to begin contracts with major potential users and potential primary and back-up sources of heat.

Funding for this phase normally will need to include grants and contributions. Loans for this phase could be repaid out of system revenues. There is the risk, however, that the loans would not be repaid if the system is not built.

7.2.4 Detailed Design and User Commitment

This phase involves detailed project planning and specific cost estimates for system construction and conversion. It requires obtaining commitments which may need to be formal long-term commitments. If necessary, financing can be arranged as part of PLANNING AND CONCEPTUAL DESIGN or it could be part of construction and implementation phase. Normally, however, this detailed planning including user commitments will be necessary in order to obtain construction and conversion financing.

Probably only short-term financing would be needed since, if the system is built, these costs would be folded into long-term financing of the system and paid through user charges.

Risks are involved in funding this phase, however, since the costs cannot be recovered if the system for any reason is not or cannot be built. The risks may be small, however, if there are general informal commitments for funding and commitments by major potential users. Much of the cost of this phase would need to be funded initially by the local community, major users, or potential system owners.

Funding options for the DETAILED DESIGN AND USER COMMITMENT phase include:

- Federal or State loans or grants
- Bank loans (direct or guaranteed)
- Municipal funds

- Potential investors funds
- Public utilities
- Potential users
- Community or business groups

The funding of this phase presents numerous difficulties. For district heating projects currently being planned, this phase has been funded in part by Department of Energy grants which may no longer be available. Detailed planning cost estimates and feasibility analysis are necessary to determine user costs which in turn are an essential prerequisite to user commitment. If the system is built, these expenses can be folded into the construction financing and paid over time as part of user charges.

If the system is not built, however, there is considerable risk involved in financing this phase. This risk can be minimized only if the feasibility of the system can be demonstrated first in terms of energy costs savings and user commitments.

The cost of this phase may vary from $50,000 or less for a small system with good community support to $500,000 or more for major systems such as the system being planned for St. Paul.

7.2.5 System Construction

This phase involves the construction of the system including providing the primary and backup sources of heat and the distribution systems. The funding sources will vary depending upon the ownership options selected. The funding options outlined here are for the combined generation and distribution systems. Separate ownership of the generation and distribution systems is certainly, however, a viable option and may be highly desirable particularly if congeneration is involved. The funding options depending upon the ownership may, therefore, involve the whole system or only part.

7.2.5.1 Municipal Ownership Funding options which can be considered if municipal ownership is contemplated include:

- General obligation bonds - This option is the lowest cost option but it is available only if the municipality is willing to commit the general taxing authority of the municipality to a project which may not directly benefit all residents or taxpayer groups.
- Revenue bonds backed with general obligation pledge for all or part of the issue. These bonds are similar to general obligation bonds and represent a low-cost option, but they do obligate the City for debt service payments

- Revenue bonds - This is a good alternative if users can be committed to clearly provide income sufficient to guarantee repayment of bonds over the life of the issue

- Revenue bonds with guarantees in full or in part by Federal or State agencies, public utilities, users, or other revenue sources such as special assessments, tax increment financing revenues, or revenues from the electric utility or an existing district heating system

- Loans from the State under the District Heating Loan Program

7.2.5.2 Private Ownership The following funding options may be considered for private system ownership:

- Equity financing by investors - In view of potential risks, a high return on investment would be required

- Private loan financing - This would require higher interest rates than tax-exempt bonds and normally would require as much or greater security than tax-exempt bonds

- Industrial revenue or other type of tax-free financing arrangements

- Municipal Lease - This concept permits the various municipally-owned funding options but transfers operation and some or all of risk to private operators

- Loans guaranteed by Federal or State agencies, municipality, or users. Such guarantees are currently in short supply, but may be available for some projects.

7.2.5.3 Municipal Electric Utility These funding options would be similar to municipal ownership although municipal utility revenue bonds would be more attractive to investors if they are backed up by the utility's assets and revenues from other operations. Utility related bonds even if guaranteed by the general obligation of the municipality have less impact on Bond ratings than direct municipal bonds.

7.2.5.4 Privately Owner Public Utilities The funding options available to privately owned public utilities would be similar to other private investors although the financial strength of the utility could result in higher loan-to-equity ratios and lower interest rates.

It can be anticipated that electrical utilities will finance the costs of converting existing facilities for cogeneration of heat. These would be repaid through energy charges to the distribution system. The large demand on utilities for financing electrical generation facilities, however, makes it unlikely that they will be interested in establishing and funding a distribution system.

7.2.5.5 **Public or Quasi-Public Agency** One ownership option normally available is a public or quasi-public agency. Tax exempt revenue bond financing would normally be available for public or quasi-public agencies and qualify for the State loan program if their board consists of the Mayor and City Council. The Revenue bond financing and state loans, however, both require demonstrated feasibility, adequate debt coverage ratios, and user commitments.

General obligation bonds can also be used under this option with the municipality selling general obligation bonds and loaning the funds to the agency.

7.2.5.6 **User or Community Cooperatives** A new cooperative would need to obtain financing in a way similar to private ownership. Since a new cooperative would not have financial reserves, the cooperative would either need substantial contribution of equity by members or loan guarantees. Potential sources of guarantees for all or part of the needed loans include:

- Federal or State agencies.
- Municipality.
- Cooperative members.

7.2.6 Building Heating System Conversions

The costs of converting a customer's building heating system may in whole or in part be included in the overall system funding and paid through higher rate charges unless not permitted by the funding sources. Typically, however, the conversions would be financed by the individual building owner or user.

There are, however, other conversion cost funding options which could assist individual users in funding their own conversion costs. These could include:

- Federal or State grants, loans, or loan guarantees.
- Local financial institution commitment to make needed loans which could be guaranteed in whole or in part by the district heating company or in some other manner.